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TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1930

No. 54

CARBICE CORPORATION OF AMERICA,
PETITIONER,

vs.

AMERICAN PATENTS DEVELOPMENT CORPORATION AND DRY ICE CORPORATION OF AMERICA

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SECOND CIRCUIT

PETITION FOR CERTIORARI FILED FEBRUARY 27, 1930

CERTIORARI GRANTED APRIL 21, 1930

(34,826)

(34,826)

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IN THE UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

In Equity. No. —

INTERNATIONAL PATENTS HOLDING CORPORATION and DRY ICE CORPORATION OF AMERICA, Plaintiffs,

vs.

CARBICE CORPORATION OF AMERICA, Defendant

BILL OF COMPLAINT

To the Honorable the Judges of the United States District Court for the Eastern District of New York:

First. International Patents Holding Corporation, a corporation organized and existing under the laws of the State of Delaware, having its official place of business at Wilmington in said state, and Dry Ice Corporation of America, State of Delaware, having its principal place of business in a corporation organized and existing under the laws of the New York, N. Y., bring this their bill of complaint against Carbice Corporation of America, a corporation organized and existing under the laws of the State of Delaware, having its principal office and place of business in Long Island City, N. Y., in the said Eastern District of New York, and for cause of action plaintiffs say:

[fol. 2] Second. This suit is brought under the laws of the United States for infringement of Letters Patent.

Third. On the 10th day of January, 1924, Thomas B. Slate, then residing at New York City, N. Y., being within the meaning of the Statutes of the United States then in force the inventor of a new and useful Method of, and Apparatus for, Refrigeration and Preserving Perishable Products, and being entitled to a patent thereon under the provisions of the said Statutes, duly filed in the United States Patent Office an application for Letters Patent of the United States therefor, and on October 14, 1924, all the requirements of the Statutes of the United States then in

force having been duly complied with, Letters Patent of the United States No. 1,511,306 were duly issued to Thomas B. Slate, said Letters Patent, or a duly certified copy thereof, being ready here in Court to be produced.

Fourth. The said Letters Patent No. 1,511,306 have been duly assigned by mesne assignments from the patentee, Thomas B. Slate, to International Patents Holding Corporation, of New York, N. Y., a corporation of Delaware.

Fifth. On the 10th day of January, 1924, Thomas B. Slate, then residing at New York City, N. Y., being within the meaning of the Statutes of the United States then in force the inventor of new and useful Improvements in Refrigerating Apparatus, and being entitled to a patent thereon under the provisions of the said Statutes, duly filed [fol. 3] in the United States Patent Office an application for Letters Patent of the United States therefor, Serial No. 685,482, from which the application for the present patent was divided and filed on September 27, 1924, bearing Serial No. 740,164, and on August 10, 1926, all the requirements of the Statutes of the United States then in force having been duly complied with, Letters Patent of the United States No. 1,595,426 were duly issued to International Patents Holding Corporation of New York, N. Y., a corporation of Delaware, said Letters Patent, or a duly certified copy thereof, being ready here in Court to be produced.

Sixth. Plaintiff International Patents Holding Corporation and its predecessors in title have granted to the plaintiff Dry Ice Corporation of America an exclusive right to manufacture, sell and use the inventions of the said patents.

Seventh. The inventions patented as aforesaid are of great commercial value and have been, and are being, used extensively by plaintiff Dry Ice Corporation of America, and the public in general has respected the validity of the said Letters Patent and has recognized plaintiffs' rights thereunder, and except for the infringement of defendant hereinafter complained of, the plaintiffs have the exclusive enjoyment of the said inventions.

Eighth. The defendant, without right and without the consent or authority, express or implied, of the plaintiffs or their predecessors, has infringed the said Letters Patent

[fol. 4] Nos. 1,511,306 and 1,565,426, and each of them, in the Eastern District of New York and elsewhere, since the issuance of the said patents, by making and using solid carbon dioxide and by selling the said product with the intent that the said product shall be used in infringing the said Letters Patent, and said defendant has encouraged and instructed others to construct or purchase apparatus and to use such product and such apparatus in a manner intended to infringe the said Letters Patent, to the great loss and irreparable damage to the plaintiffs.

Ninth. The defendant has been duly notified of plaintiffs' rights under the aforesaid patents, and of its infringement of the said patents, as is set forth in paragraph Eighth hereof, and the defendant has without right or license continued its infringing acts and threatens to continue them, to the great loss and damage of the plaintiffs.

Wherefore the plaintiffs pray:

1. That the defendant make answer to this bill of complaint, but not under oath, answer under oath being expressly waived.

2. For an injunction and a preliminary injunction pending this suit restraining this defendant, its servants, agents and employees, from infringing the said Letters Patent, or either of them.

3. For costs and an accounting of profits and damages, and that any damages assessed may be trebled.

[fol. 5] 4. For such other and further relief as the circumstances of the case may require.

International Patents Holding Corporation and Dry Ice Corporation of America, by Clarence D. Kerr, Attorney. Charles Neave, Clarence D. Kerr, George C. Dean, of Counsel.

Duly sworn to by Robert R. Rust. Jurat omitted in printing.

[fol. 6] IN UNITED STATES DISTRICT COURT

[Title omitted]

ANSWER

Now comes defendant and for its answer to the Bill of Complaint herein or as much thereof as it is advised, is necessary or desirable to be answered says:

1. This defendant denies each and every allegation contained in paragraph third of the said Bill of Complaint except that it admits having seen what purported to be a copy of Letters Patent No. 1,511,306 issued to Thomas B. Slate on or about the 14th day of October, 1924.

2. This defendant denies each and every allegation contained in paragraph fourth of the Bill of Complaint.

3. This defendant denies each and every allegation contained in paragraph fifth except that it admits having seen [fol. 7] what purported to be a copy of Letters Patent No. 1,595,426 granted on or about August 10, 1926 to Thomas B. Slate.

4. This defendant denies each and every allegation contained in paragraph sixth of the Bill of Complaint.

5. This defendant denies each and every allegation contained in paragraph seventh of the Bill of Complaint.

6. This defendant denies each and every allegation contained in paragraph eighth of the Bill of Complaint.

7. This defendant admits having been notified by plaintiffs of their alleged rights but denies that its operations were or are an infringement of said patents or plaintiff's rights and denies that plaintiffs have been subjected to any loss or damage by defendant's alleged acts.

Further answering said Bill of Complaint defendant alleges:

8. Defendant is informed and believes and therefore avers that said Letters Patent No. 1,511,306 and 1,595,426 are invalid and void because,

(a) For the purpose of deceiving the public, the description and specification filed by the patentee in the Patent Office in each of said patents was made to contain less than the whole truth relative to his alleged invention or dis-
[fol. 8] covery or more than is necessary to produce the desired effect.

(b) That the patentee surreptitiously or unjustly obtained the patent for that which was invented by others who were using reasonable diligence in adapting and perfecting the same, the names and residences of the persons who invented the same, and the dates defendant is not at present advised, and begs leave to add hereto by proper amendment to this its answer, when such information is obtained.

(c) The alleged invention of each of said patents has been patented or described in printed publications, prior to the patentee's supposed invention or discovery thereof, or more than two years prior to his alleged applications for patents therefor, the names of the publications and the dates thereof, this defendant is not at present advised and begs leave to add hereto by proper amendment to this its answer.

(d) The alleged patentee was not the original and first inventor or discoverer of any material or substantial part of the thing patented, in each instance, but, to the contrary, the alleged invention and all material and substantial parts thereof, was first invented and discovered by others. The names and addresses of said persons, the dates thereof and
[fol. 9] the persons who had knowledge thereof, are at present unknown to the defendant, and it begs leave to add the same hereto by proper amendment to this its answer when such information is obtained.

(e) That the alleged invention of each of said patents had been in public use or on sale in this country for more than two years before the alleged application for patent or had been abandoned to the public. The names and addresses of the persons having such knowledge and establishing such use and where and by whom the alleged invention had been used, this defendant is not at present advised, but begs leave to add hereto by proper amendment to this its answer when this information is obtained.

(f) Because the alleged invention purported to be patented, did not constitute patentable knowledge of invention within the meaning of the Patent Laws in view of the prior state of the art, and, in view of what was common knowledge on the part of those skilled in the art at or prior to the alleged invention of said Letters Patent.

9. Defendant is informed and believes and therefore avers that while the said applications for said Letters Patent Nos. 1,511,306 and 1,595,426 were pending in the United States Patent Office the applicant so limited and confined the claims of said application under the requirements of the Commissioner of Patents, in view of the prior [fol. 10] art, that the plaintiffs herein cannot now seek for or obtain constructions for such claims sufficiently broad to cover any apparatus or devices made, used or sold by defendant.

Wherefore the defendant denies that plaintiff is entitled to the relief prayed for in the said Bill of Complaint or to any relief and prays to be hence dismissed with its costs in this cause sustained and for such other and further relief as to the Court may seem just.

Carbice Corporation of America, by Darby & Darby, Attorneys. Darby & Darby, Solicitors for Defendant, No. 220 Broadway, New York, New York. Samuel E. Darby, Jr., of Counsel.

Dated New York, New York, June 10, 1927.

[fol. 11] IN UNITED STATES DISTRICT COURT

[Title omitted]

AMENDED ANSWER

For an amended answer to the bill of complaint herein the defendant says:

1. This defendant denies each and every allegation contained in paragraph third of the said bill of complaint except that it admits having seen what purported to be a copy

of Letters Patent No. 1,511,306 issued to Thomas B. Slate on or about the 14th day of October, 1924.

2. This defendant denies each and every allegation contained in paragraph fourth of the bill of complaint.

3. This defendant denies each and every allegation contained in paragraph fifth except that it admits having seen what purported to be a copy of Letters Patent No. 1,595,426 granted on or about August 10, 1926, to Thomas B. Slate.

[fol. 12] 4. This defendant denies each and every allegation contained in paragraph sixth of the bill of complaint.

5. This defendant denies each and every allegation contained in paragraph seventh of the bill of complaint.

6. This defendant denies each and every allegation contained in paragraph eighth of the bill of complaint.

7. This defendant admits having been notified by plaintiffs of their alleged rights but denies that its operations were or are an infringement of said patents or plaintiffs' rights and denies that plaintiffs have been subjected to any loss or damage by defendant's alleged acts.

8. This defendant further answering said bill of complaint on information and belief alleges that said alleged Letters Patents and each of them are and always have been invalid and void and of no force and effect, because of each and every of the facts hereinafter set forth, to wit:

(a) That for the purpose of deceiving the public, the description and specifications filed by the patentee in the Patent Office, in each of said patents was made to contain less than the whole truth relative to his alleged inventions or discoveries or more than is necessary to produce the desired effect.

(b) That all things alleged or supposed to be patented by said alleged Letters Patents, and each of them, have [fol. 13] been known to others prior to the date of the alleged inventions thereof by said Thomas B. Slate, and have been in public use in this country for more than two years prior to the applications for patents therefor, to wit:

John E. Starr, of 41 E. 42nd Street, New York, N. Y., at St. Louis, Mo., and elsewhere within the United States.

Frank L. Sorenson, of 157 Lothrop Street, Detroit, Mich., at Detroit, Mich., and elsewhere within the United States.

Frank D. Sorenson, of 157 Lothrop Street, Detroit, Mich., at Detroit, Mich.

J. C. Goosman, Waynesboro, Pa., at Chicago, Ill., and elsewhere within the United States.

J. C. Churchill of New York City, at Penn State University, Pa.

and by divers and sundry other persons whose names and addresses and the places of whose use of said invention this defendant cannot now set forth with certainty but begs leave to set forth by amendment hereto when it shall become more fully advised and informed.

(c) That in view of the prior art specified in paragraph (e) hereof at the time the alleged inventions are claimed to [fol. 14] have been made by said Thomas B. Slate, each and all of the elements which are essential or which relate to the described subject matter of said alleged inventions and contained in said alleged Letters Patents and in each and every of the claims thereof, was and were old and well known long prior to the alleged inventions of said Thomas B. Slate, and that each and all of said claims in said patents are void for want of novelty.

(d) That in view of the prior art specified in paragraph (e) hereof at the time of the alleged inventions described in said Letters Patent are claimed to have been made by said Thomas B. State, the matters set forth in each and all of the claims of each of said Letters Patents involve no exercise of the alleged inventor's powers of invention or original discovery, but could have been produced by the employment of mere mechanical skill and that each and all of said claims, of each of said patents, are void for want of invention.

(e) That each and every of said alleged inventions and improvements, in each of said patents, and each and every essential and material part thereof, was well known in this country long prior to the alleged inventions thereof by said Thomas B. Slate, and particularly this defendant says that said inventions, and every material part thereof, had been [fol. 15] described and illustrated in printed publications prior to the supposed date of said alleged patents and prior

to the date of said alleged inventions of said Thomas B. Slate, as follows, to wit:

In Letters Patent of the United States

Name	Number	Date
Dickerson, Jr.	256,299	April 11, 1882
Bobrick	672,257	April 16, 1901
Emmens	652,759	July 3, 1900
Julius	1,018,568	Feb. 27, 1912
Moore	281,387	July 17, 1883
Moslery & Ladewig	236,906	Jan. 25, 1881
Windhausen	236,471	Jan. 11, 1881
Coleman	226,281	April 6, 1880
Johnson	266,160	Oct. 17, 1882
Josephson	1,525,095	Feb. 3, 1925
Josephson	1,515,119	Nov. 11, 1924
Josephson	1,497,278	June 10, 1924
Ostergren	686,531	Nov. 12, 1901
Muller	891,560	June 23, 1908
Cremieu	1,421,176	June 27, 1922
Goosmann	947,382	Jan. 25, 1910
Flemming	955,454	April 19, 1910
Dumars	954,268	April 5, 1910
Hargrave	625,760	May 30, 1899
Rumpel	1,130,932	March 9, 1915
Elsworthy	579,866	March 30, 1897
Lundin	1,133,299	March 30, 1915
Coffin	1,039,098	Sept. 24, 1912
Thwaits	1,595,633	Aug. 10, 1926
Cabot	1,140,250	May 18, 1915
Klotz	697,496	April 15, 1902
Cole	1,547,903	July 28, 1925

[fol. 16] British Patents

Name	Number	Date
Elsworthy	2,450	1906
Read	27,576	1909
Hall	10,378	1910
Walker	10,655	1892
Seiffert	26,792	1902
Elsworthy	21,518	1891
Elsworthy	7,436	1895
	9,909	1909

French Patents

Crepin	333,181	1903
Societe Des Gas Radioactifs Naturels De Colombieres-Sur-Orb.	514,037	1920

German Patents

Heylandt	193,116	1906

and in divers other United States patents and in patents of countries foreign to the United States, and in divers and other sundry publications, which Letters Patents and publications this defendant cannot now set forth with particularity and which when hereafter ascertained, it begs leave to set forth by proper amendment.

(f) That said alleged inventions, in each of said patents [fol. 17] were known and practiced in the United States prior to the alleged inventions thereof by said Thomas B. Slate, and more than two years before the dates of said applications by said Thomas B. Slate for said alleged Letters Patent, by the persons and at the places as follows, to wit:

John E. Starr, of 41 E. 42nd Street, New York, N. Y., at St. Louis, Mo., and elsewhere within the United States.

Frank L. Sorenson, of 157 Lothrop Street, Detroit, Mich., at Detroit, Mich., and elsewhere within the United States.

Frank D. Sorenson, of 157 Lothrop Street, Detroit, Mich., at Detroit, Mich.

J. P. Lavigne, of 251 Lincoln Avenue, Detroit, Mich., at Detroit, Mich.

Dr. Guy F. Lathrop, of Stevens Building, Detroit, Mich., at Detroit, Mich.

J. C. Goosman, Waynesboro, Pa., at Chicago, Ill., and elsewhere within the United States.

H. D. Hutchins, of Detroit, Mich., at Detroit, Mich.

Dr. Joseph R. Applegate, of 7880 V. Dyke Pl., Detroit, Mich., at Detroit, Mich.

J. C. Churchill, of New York City, at Penn State University, Pa.

and by divers and sundry other persons whose names and [fol. 18] residence and the places of whose use of said in-

ventions this defendant cannot now set forth with certainty but begs leave to set forth by amendment hereto when it shall become more fully advised and informed.

9. Defendant is informed and believes and therefore avers that while the said applications for said Letters Patents Nos. 1,511,306 and 1,595,426 were pending in the United States Patent Office the applicant so limited and confined the claims of said application under the requirements of the Commissioner of Patents, in view of the prior art, that the plaintiffs herein cannot now seek for or obtain constructions for such claims sufficiently broad to cover any apparatus or devices made, used or sold by defendant.

Wherefore the defendant denies that plaintiffs are entitled to the relief prayed for in the said bill of complaint or to any relief and prays to be hence dismissed with its costs in this cause sustained and for such other and further relief as to this Court may seem just.

Carbice Corporation of America, by Darby & Darby,
Its Attorneys. Samuel E. Darby, Jr., of Counsel.

Dated New York, N. Y., November 14, 1927.

[fol. 19] IN UNITED STATES DISTRICT COURT

[Title omitted]

PETITION FOR LEAVE TO FILE A SUPPLEMENTAL BILL OF COMPLAINT

Your petitioners, American Patents Development Corporation and Dry Ice Corporation of America, both corporations organized and existing under the laws of the State of Delaware and having their principal places of business in the City and Southern District of New York, represent:

1. That they are now the owners of, respectively, (1) the legal title to Letters Patent Nos. 1,511,306 and 1,595,426 herein sued on; and (2) the exclusive right and license to manufacture, sell and use the inventions of said patents.

2. That since this suit was filed on May 10, 1927, the legal title to the said patents has been assigned, transferred

[fol. 20] and conveyed to your petitioner, American Patents Development Corporation, together with all the rights possessed by the plaintiff, International Patents Holding Corporation, at the time the suit was filed.

3. That since this suit was filed on May 10, 1927, the exclusive right and license to manufacture, sell and use the inventions of said patents has been assigned, transferred and set over to your petitioner, Dry Ice Corporation of America, together with all the rights possessed by the plaintiff, Dry Ice Corporation of America, at and since the time the suit was filed, including the right to recover damages and profits in this cause, your petitioner, Dry Ice Corporation of America, being of the same name as the predecessor corporation.

4. Your petitioners therefore pray for leave to file the annexed supplemental bill of complaint, setting out the foregoing material facts which occurred after the filing of the original bill of complaint, or of which your petitioners were ignorant when such bill was filed, and substituting your petitioners as plaintiffs in the said suit.

Respectfully, American Patents Development Corporation, Dry Ice Corporation of America, by Charles Neave, Clarence D. Kerr, Solicitors.

[fol. 21] IN UNITED STATES DISTRICT COURT

[Title omitted]

ORDER GRANTING PETITION FOR LEAVE TO FILE SUPPLEMENTAL BILL OF COMPLAINT

On reading and filing the annexed petition in the above entitled cause and supplemental bill of complaint referred to therein, and upon due consideration thereof, it is hereby ordered:

(1) That the American Patents Development Corporation and Dry Ice Corporation of America be and hereby are substituted as plaintiffs in place of the original plaintiffs in the above cause;

(2) That the supplemental bill of complaint be and the same is hereby filed herewith;

(3) That the defendant have ten days from the service of this order to file an answer to the said supplemental [fol. 22] bill; otherwise the allegations contained in the said supplemental bill shall be deemed to be denied on information and belief; and

(4) That the case shall retain its place on the equity trial calendar.

Marcus B. Campbell.

Dated January 19, 1928.

The entry of the foregoing order is consented to.
January 16, 1928.

Darby & Darby, Solicitors for Defendant.

[fol. 23] In United States District Court

[Title omitted]

Supplemental Bill of Complaint

Plaintiffs for a supplemental bill of complaint allege the following facts supplemental to the allegations of the original bill of complaint occurring after the filing of the said original bill, or of which they were ignorant when said original bill of complaint was filed:

1. That the substituted plaintiffs herein, American Patents Development Corporation and Dry Ice Corporation of America, are both corporations organized and existing under the laws of the State of Delaware and have their principal places of business in the City and Southern District of New York.

2. That since the filing of the original bill of complaint the legal title of Letters Patent Nos. 1,511,306 and 1,595,426 [fol. 24] has been duly assigned, transferred and conveyed by mesne assignments to the plaintiff herein, American Patents Development Corporation, together with all the rights possessed by International Patents Holding Corporation at the time the suit was filed.

3. That the exclusive right to manufacture, sell and use the inventions of the said patents heretofore granted to the Dry Ice Corporation of America, one of the original plaintiffs, as is averred in paragraph "Sixth" of the original bill of complaint, has been duly assigned, transferred and set over to the substituted plaintiff, Dry Ice Corporation of America, a corporation of the same name as that of the original plaintiff, together with all the rights possessed by the original plaintiff, Dry Ice Corporation of America, at and since the time the suit was filed, including the right to recover damages and profits in this cause.

Wherefore the substituted plaintiffs pray that they may have leave to prove the facts herein alleged at the trial of this cause, that the defendant be required to make answer thereto, and that they may have relief as prayed for in the original bill of complaint in the place and stead of the original plaintiffs, and such other and further relief as may be just in the premises.

American Patents Development Corporation and Dry Ice Corporation of America, by Charles Neave, Clarence D. Kerr, Solicitors.

[fol. 25] *Duly sworn to by Robert R. Rust. Jurat omitted in printing.*

[fol. 26] IN UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

AMERICAN PATENTS DEVELOPMENT CORPORATION (Substituted for International Patents Holding Corporation) and Dry Ice Corporation of America

against

CABRICE CORPORATION OF AMERICA

Before Hon. Marcus B. Campbell, U. S. D. J.

Statement of Evidence

Brooklyn, N. Y., February 24, 1928.

APPEARANCES OF COUNSEL

Charles Neave, Esq., Clarence D. Kerr, Esq., for the Plaintiff.

Messrs. Darby & Darby, Samuel E. Darby, Jr., for the Defendant.

COLLOQUY BETWEEN COURT AND COUNSEL

Mr. Kerr: We are relying on Claims 2, 3, 4, 6, 7 and 9.

Mr. Kerr: I would like an order discontinuing the bill as to patent No. 1,511,306, without prejudice.

[fol. 27] The Court: All right.

Mr. Kerr: I understand that Mr. Darby concedes the incorporation of the present plaintiffs.

Mr. Darby: Yes.

Mr. Kerr: I offer in evidence the Slate patent in suit No. 1,595,426.

(Marked Plaintiff's Exhibit 1 in evidence.)

The Court: If you do not charge them with having made and sold any of the packages of the character described in these several claims, what is there to litigate?

Mr. Kerr: We charge them with having sold ice specifically to go into the patented packages with knowledge exactly how it was to be used.

The Court: Have you any patent for the ice?

Mr. Kerr: The ice is an essential element of the structure set forth in the claims.

The Court: I will look at it. That would be contributory infringement at the most.

Mr. Kerr: We charge them only with contributory infringement.

The Court: That would be the most.

Mr. Kerr: And with complete knowledge as to how the ice was to be used by these various customers, former customers of ours, and for a time customers of theirs.

The Court: Unless the ice formed part of the combination, I have some doubt about your being able to hold it. I just read the claims casually and they seem to be for the structure. Non constat, the structure might be used with many things. We may not know them at the time, but there may be other refrigerants that may yet to be discovered.

[fol. 28] Mr. Kerr: Claim 2 reads:

"A heavily insulated package enclosing in close proximity to a parcel or mass of material not damaged by overfreezing during shipment, a quantity of frozen carbon dioxide insulated from but in freezing relation to said parcel or mass, so that portions of the material are more directly and intensely refrigerated than other portions for the purpose and with the result of sufficiently refrigerating more remote portions."

The Court: I will look at it.

Mr. Kerr: And then it goes on and defines that the gas escaped in insulating relation to the material.

The Court: I will take it. I have a doubt, however, that you have invented more than a structure.

Mr. Kerr: If the invention is only a structure, if they contribtue toward the creation of that structure——

The Court: If the invention is for a structure in combination with the ice, then they are contributory infringers. If I made a bicycle and someone furnished oil which was infringing oil, which lubricated the parts, I would not be a contributory infringer because I made the bicycle, would I?

Mr. Kerr: It would depend.

The Court: If I made a bicycle and in the use of that used a lubricating oil which was infringing a patent, I [fol. 29] would not be a contributory infringer because I made the bicycle which was capable of using that oil, because the patent would not cover that oil. I am going to look it over.

Mr. Kerr: Of course you may have every element in the claim oil.

The Court: That is what I am going over.

Mr. Kerr: Suppose they are all old, it still can be a valid claim, because you get a new result from it.

The Court: Let us look at it. Suppose you manufacture a refrigerator which was patented and it was adapted to use ice as a refrigerating material, and you also were the manufacturer of artificial ice. Now, someone else manufactured artificial ice; would they be a contributory infringer because they furnished that artificial ice to a person who was using the refrigerator?

Mr. Kerr: If the ice was a necessary and essential element of the claim, they would be. If it was not a necessary and essential element of the claim they would not be.

The Court: All right.

Mr. Kerr: Mr. Darby has consented to my putting in photostatic copies of the title. I offer in evidence assignment of the International Patents Holding Corporation to the International Patents Fiscal Corporation.

(Marked Plaintiff's Exhibit 2 in evidence.)

Mr. Kerr: I offer in evidence assignment of the International Patents Holding Corporation and International Patents Fiscal Corporation to Benjamin W. Reuben, dated June 10, 1927.

(Marked Plaintiff's Exhibit 3 in evidence.)

[fol. 30] Mr. Kerr: I offer in evidence assignment of Benjamin W. Reuben to American Patents Development Corporation, dated December 29, 1927.

(Marked Plaintiff's Exhibit 4 in evidence.)

Mr. Kerr: I offer in evidence exclusive license from Thomas B. Slate to Prest Air Corporation, dated December 3, 1924.

(Marked Plaintiff's Exhibit 5 in evidence.)

Mr. Kerr Mr. Darby has waived proof of the fact that the Pressed Air Corporation changed its name to the Dry Ice Corporation.

Mr. Darby: Please give the date when they changed the name.

Mr. Kerr: March, 1925.

I offer assignment of license from the original Dry Ice Corporation of America to the new Dry Ice Corporation of America, dated October 31, 1927.

(Marked Plaintiff's Exhibit 6 in evidence.)

JAMES W. MARTIN, JR., called as a witness on behalf of the plaintiff, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

I reside at 130 Manhattan Avenue, Crestwood, New York. I am the assistant to the President of the plaintiff, Dry Ice Corporation. I was employed on January 19, 1925, as chief engineer of the predecessor of the Dry Ice Corpora-
[fol. 31] tion. Later, in April of 1926, I took charge of the sales and the production and the engineering for the Dry Ice Corporation.

The Dry Ice Corporation is in the business of developing all of the uses possible for solid carbon dioxide. It manufactures the solid carbon dioxide for these uses.

The early commercial work of the company consisted in the development of uses of packages and methods with which this solid carbon dioxide could be used commercially. It taught to the respective customers these methods.

The Dry Ice Corporation began selling solid carbon dioxide commercially in May, 1925. Our practice in selling our product to a customer was first to teach him how to use this product, that is, how he could obtain commercial use for the product, inasmuch as it must be used in certain ways in order to obtain its full commercial value. We first taught him how to use it, and then attempted to sell him the idea of using this solid carbon dioxide in place, usually, of water ice, which he had previously been using.

The packages in which our customers began using this solid carbon dioxide were insulated. In these packages the solid carbon dioxide was placed, in the case of ice cream, in freezing proximity to the product, but they were special packages that had been worked out by us in our laboratories, specially designed, I should say.

Q. Will you please give a tabulation in pounds as to the amount of solid carbon dioxide you sold for use in refrigerating containers since March, 1925?

[fol. 32] Mr. Darby: I object to that as wholly immaterial.

The Court: I do not know whether he pleaded great commercial success or not.

Mr. Kerr: We did.

Mr. Darby: He pleaded great commercial success as far as the first patent, which is withdrawn, is concerned, but the amount of carbon dioxide sold has no bearing on the package for shipping.

The Court: I will let him show it.

Mr. Kerr: The witness produces a tabulation which is to be copied in to the record.

(The tabulation is as follows):

February 14, 1928.

Growth in Sales

Pounds of Solid CO_2 (Dry-Ice) per Month

	1925	1926	1927
January		33,613 pounds	98,029 pounds
February		26,868 "	114,854 "
March	*2,000 pounds	24,678 "	138,831 "
April	24,228 "	43,469 "	155,852 "
May	34,390 "	88,947 "	249,607 "
June	29,071 "	111,543 "	308,465 "
July	23,046 "	136,456 "	426,909 "
August	42,162 "	143,718 "	519,670 "
September	48,653 "	129,036 "	340,066 "
October	78,394 "	130,983 "	369,790 "
November	33,608 "	100,370 "	259,292 "
December	51,303 "	124,159 "	430,666 "
	366,855	1,093,840	3,412,031
			1,093,840
			366,855
Total			4,872,726

* Delivered but not billed.

[fol. 33] Q. At any time during your manufacture of solid carbon dioxide has the demand for your product exceeded your production?

A. Yes, sir; in the summer of 1926 we were producing solid carbon dioxide at the plant of the General Carbonic Company, and our demand was about 5 tons a day, and we had obtained a promise for this amount from the General Carbonic Company, but it was suddenly discovered at that time that they could not or did not give us but 2½

tons per day, and we were obliged to curtail the shipments to many of our customers at that time. Subsequent to that we left the plant of the General Carbonic Company, in which were were producing solid CO_2, and went to other sources of liquid carbon dioxide from which to produce the solid.

By the Court:

Q. Is it just carbonic acid gas solidified?
A. Yes, it is carbonic gas solidified.

By Mr. Kerr:

Q. Will you explain to the Court how this operation takes place?

A. The liquid carbon dioxide is expanded, and in expansion part of it freezes and becomes carbon dioxide snow. This carbon dioxide snow is compressed into these blocks known as solid carbon dioxide. Prior to 1927 the following companies purchased solid carbon dioxide from the Dry Ice Corporation: Frank J. Shattuck Company; Con- [fol. 34] solidated Dairy Products Company; Maresi-Mazzetti Corporation; Marchiony Spumoni Company; Louis Sherry, Inc.; Du Barry; Longchamps; Wills Jones Company; Barden Brothers; Philadelphia Dairy Products Company. All of these companies were instructed by our representatives as to how to use "dry ice" in the packages and containers that were to be refrigerated. The design of these packages was given them in most cases from our engineering department.

By the Court:

Q. Did you ever manufacture and sell, and if so, how many, packages or containers which you contend were made under your patent?

A. We manufactured no containers, sir.

By Mr. Kerr:

Q. Did you lose the business of any of these companies during 1927, and if so, which ones?

A. We lost the business of all these companies for a certain time during the year of 1927, partially or in whole. We are now doing business with all of these companies.

I know W. E. Ditmars. I first met him on August 5th of 1926, when Mr. Ditmars called in my office and we dis-
[fol. 35] cussed the manufacture and sale of dry ice, he at that time representing himself to be connected with the Southern Dairies, Inc., I think it is, of Washington, whom we desired to obtain as a customer for the next season. Subsequently, on October 15th, Mr. Ditmars again called at our office, and among other things, requested that we would permit him to visit our plant. We had learned by that time that he was interested in the manufacture of solid CO_2, and this request was denied. We have had no competition to amount to anything except from the defendant in this case. We have no competition at the present time that we know of.

The paper handed me is an invoice form upon which the Dry Ice Corporation sends to its customers their bills. It has been used since we started business. I would say May, 1925. The notice at the foot of the invoice has not been changed in its essential form, since we put it out.

Mr. Kerr: The invoice is offered in evidence as Plaintiff's Exhibit No. 7.

Mr. Darby: I object to it as irrelevant and immaterial. I do not see that it has any pertinency in the case whatever.

The Court: I do not know what they charge you with—unfair competition?

Mr. Darby: No, sir, ordinary acts of infringement.

The Court: What do you want it for?

Mr. Kerr: Simply to show when the plaintiff sold this dry ice they licensed the buyers of it to use their patented
[fol. 36] container inventions, using the ice as part of their patented containers.

The Court: I think I will take it. Am I to infer from that that if they sold it without license they would not be entitled to use it?

Mr. Kerr: No, I think they would have an implied license, but this is a definite notice to all of their customers.

The Court: I will take it.

(Marked Plaintiff's Exhibit 7 in evidence.)

Mr. Kerr: Direct examination closed.

Cross-examination.

By Mr. Darby:

Q. Mr. Martin, you used the expression once or twice in your testimony of competition, competition that your company ran into with the Carbice Company. Competition in what? The sale of solid carbon ice?

A. Yes, I should say the competition was in the sale of carbon dioxide ice.

Q. That is the only competition you had?

A. The competition we were most interested in was the use of the solid CO_2 ice in our patented containers. I said in answer to the Court's question that we did not make or sell patented containers. I would not say that our whole business was the sale of solid ice. We have licenses from which some of our income is obtained. Our whole income, so far as what we make and sell, is from the solid carbon dioxide which we manufacture ourselves.

[fol. 37] Q. And you referred to the fact you sell this carbon ice in insulated containers, insulated packages. What do you understand by that term insulated?

A. I think you are misquoting me a bit in that. We sell the ice for use in packages containing refrigerated products, the package that contains the refrigerated products and the ice is insulated.

Q. What I am trying to get at is what is an insulation member?

A. An insulation member I believe would be anything that would inhibit or slow up the transfer of heat. Insulation is a relative term.

Q. Anything is insulated as compared to something which is more conductive?

A. I think that would lead us far astray if you were going to stick to commercial meanings.

By the Court:

Q. Would a piece of newspaper be insulation?

A. Yes.

Q. If wrapped in newspaper or flannel, that would be insulated?

A. We have found a decided insulating in wrapping of one thickness of paper there. It has a big effect.

By Mr. Darby:

Q. The terms carbon dioxide and carbonic acid are synonymous in this art?

A. There is a differentiation, I believe, in the minds of chemists. They speak of the acid as containing the acid radical. It seems to be used interchangeably in this art.

[fol. 38] Q. I think you referred to the fact that the Shattuck Company was one of your customers at one time?

A. Yes, it is. That is the Schrafft Company. They are one of the ones to which we sold our solid carbon dioxide. The Shattuck Company is one of the companies that we instructed how to use this solid carbon dioxide and the type of containers to use. They used solid carbon dioxide in the sale of pints or quarts of ice-cream. I am familiar wih the type of containers they employed for that purpose. We approved of that container. That container consisted of a cylindrical package of a kind known as a Sealright, in the particular use put to it. In this outer container was placed an insulating wall of corrugated board, the corrugations not closed, so as to permit the flow of gas to act as an insulator. Inside of this insulated container the pint or quart—usually it is a pint—of ice cream is placed, and dry ice is placed on top of that, sometimes, but not always, contained in a little paper sack.

That container was a round cylinder of cardboard, on the inside of which was a layer of corrugated paper. Inside of that was a cylindrical carton containing the ice cream with a piece of carbon dioxide on top. There was also a vented cover to let the gas out. That was the carton we approved of, showed them how to use. I should think that one has to have something to put solid carbon dioxide in if one is going to use it at all. If one is going to use it as a refrigerating element one has to put it in some way in a receptacle of some kind. You must not handle it too long in [fol. 39] your hands. Our factory at the present time, one is at Yonkers, one at Maspeth, Long Island, and one at Philadelphia.

And I presume the factory in Long Island supplies our customers in this part of the city, Brooklyn and southern New York, depending on demands. For carrying it from the place it is made to the customer we put it in an insulated truck, the pieces on top of each other, very much as in the water ice wagon. The truck is insulated. We do not put any foodstuffs in the truck, to be refrigerated by it. The truck is for delivering the ice itself. In making deliveries of smaller amounts than what is contained ordinarily in the truck, we have a motorcycle with a side car on it for such purpose.

Q. What is the container you use?

A. It is placed in there in most cases bare, or sometimes wrapped in paper. It is not common practice to use small boxes that you stick the solid carbon dioxide in. I imagine they would use boxes as a tote box. They might have done that. We did not supply them to our drivers.

Q. The outstanding thing about it is in delivering from your factory to the customer you generally put something around it, either the walls of the truck——

A. Yes.

Q. Or a piece of paper or something of that kind?

A. Certainly; they have the truck walls around it.

Q. And in one instance you gave me you said a piece of paper?

A. I would say it is wrapped in paper, particularly the little cubes now used by the Schrafft organization, you have have something to hold them together. You cannot carry [fol. 40] an armful of them. The drivers wear gloves. That we insist on.

Q. And of course you take the benefit of whatever insulation the paper or what-not gives you?

A We take advantage of anything we can get to save the ice.

I testified that some eight or nine companies that were customers of ours ceased to be our customers and became the customers of Carbice Company, the defendant. All of them have come back to us, I believe. I checked up and I believe that is correct. I would not say that we made quite a point of trying to get these customers back. We naturally endeavored to get them back when they left the fold. The

salesmen I think called on at least one-third of those that left.

Q. And one of the arguments employed in talking to these respective customers was calling their attention very forcibly to the patent rights of your company?

A. That would be purely hearsay on my part. I did not call on the customers.

Q. What is your understanding as to that?

A. I would have to go back and refresh my mind on that.

Q. You know, do you not, as a matter of fact, that one of the arguments that was employed and approved of by your officials in getting these customers back was by telling these customers that the Carbice Company were infringers of your patents, and that they themselves became liable by being their customers?

A. Yes, I think you will find that on the invoice, and I see no reason why they should not. I cannot tell you defi- [fol. 41] nitely, but I can imagine our salesmen would have used that same argument.

Q. That the customer would become liable for infringement in view of the fact they were handling the Carbice product, against which company you started suit?

A. It would be poor business policy to bring suit against the customer. I think that has been the policy. We consider it poor business to bring suit against a customer.

Q. Your policy, however, did not deter you from calling to the attention of the customer that they were liable to suit?

A. No, we did that on every bill.

Q. You did it specifically with these customers you lost out of your fold?

A. I a sorry, I cannot testify to that direct. I should think the salesmen who called would know.

Q. Wouldn't those salesmen be under somebody's supervision?

A. Yes, sir.

Q. Who would instruct them what to say and what to do in trying to get the customer back?

A. Not as to details.

Q. But with respect to as important a matter involving customers taken away from you by your only competitor——

A. I do not wish to fence with you on that point, Mr. Darby, but if you let me know exactly what you wish.

Q. Let us take the case of Shattuck or Schrafft. Is it not a fact that while the Schrafft Company, Shattuck Company, were customers of the Carbice Corporation, the defendant in this suit, that your salesmen, as well as officials of your company, went to them and told them that they would be sued for infringement of your patents if they con-

[fol. 42] tinued to buy solid carbon dioxide from the Carbice Corporation?

A. I *do not* know that as a matter of fact. I do know there were many conferences with the Shattuck people. Of course, there were many visits in an endeavor to get them back. I know that of my own knowledge.

Q. Do you know what arguments were employed at those visits in the endeavor to get them back and away from the Carbice Corporation—what reasons were advanced that they stop Carbice purchases?

A. Dependability was the thing we urged the strongest, the fact we had a greater source of supply. We were the older company, if you will, that we had a large engineering force that was at work on developing ways and means. There was a discussion which I think probably you have in mind as to the carton.

Q. The patents?

A. All of those points were probably discussed.

Q. And the patents were discussed, were they not, as well as the pendency of this suit against Carbice?

A. I do not know that the specific patents were discussed.

Q. How about the suit against Carbice, was that discussed?

A. I won't say for sure. I do not see how it could have been left out, I will put it that way.

I know Mr. D. H. Killefer wrote an article "Solid Carbon Dioxide, a new Commercial Refrigerant," in the Industrial and Chemistry Magazine, Volume 19, No. 2, February, 1927. I am familiar with that article. As a matter of fact, I assisted Mr. Killefer considerably in preparing that article.

The article ends up with this statement:

[fol. 43] "The processes of manufacture and use of solid carbon dioxide described in this article are subjects of pat-

ents and applications controlled by the Dry Ice Corporation. To this corporation and more particularly to Mr. J. W. Martin and Mr. W. L. Hood of its staff the author's thanks are extended for co-operation in preparing it."

I am the J. W. Martin referred to there. Mr. Hood is our production manager. This was not a form of advertisement by the Dry Ice Corporation.

This photostat handed me has every appearance of being a photostat of the article referred to. We have the original here.

Mr. Darby: I ask to have the photostat marked for identification.

(Marked Defendant's Exhibit A for identification.)

Mr. Killefer was until the 1st of February, 1928, assistant editor or associate editor of this journal you mentioned, and is now technical director of the Dry Ice Company. In other words, he is associated with the plaintiff company now.

Redirect examination.

By Mr. Kerr:

Q. In May, 1925, when the Dry Ice Company began commercial operations, to your knowledge was there use of solid carbon dioxide in containers at that time?

[fol. 44] Mr. Darby: I would like to know of the witness's knowledge of the art.

The Court: Ask him.

By Mr. Darby:

Q. What was your knowledge of the art of solid carbon dioxide prior to May, 1925—what was your experience in the matter?

A. My experience had been since January 19, 1925, directly connected——

The Court: Prior to that.

Mr. Darby: What experience you had with solid carbon dioxide prior to 1925.

The Witness: Prior to January, 1925, my experience had been merely the layman's experience and what I had read.

Mr. Kerr: My question related to the time in May..

The Court: He said his experience was that of a layman, so he had none.

Mr. Kerr: He had been four months active in the work, and if there was competition or use of that sort, he would know it.

The Court: During the first four months you were engaged in this endeavor did you find anybody else in the business.

The Witness: I did not.

(Witness excused.)

[fol. 45] Louis S. Marchiony, called as a witness on behalf of the plaintiff, being duly sworn, testified as follows:

Direct examination

By Mr. Kerr:

I reside at 155 Bleecker Street, New York City. I am an ice cream manufacturer. The name of my company is Marchiony Spumoni Company. I am President and Treasurer of it. We sell our ice cream to retailers, wholesalers, ice cream manufacturers, confectioners, and so forth. We refrigerate our ice cream with dry ice. Solid carbon dioxide. In packing and shipping ice cream we use various insulated containers of corrugated board or Balsa board, mineral wool, and so forth, and we pack the ice cream around the container and place the solid carbon dioxide in the center so as to refrigerate the contents, the ice cream. In speaking of packing the ice cream around the container, I mean around the inside walls of the container. The ice cream is usually put up and packed in pint and quart packages.

This is a cardboard carton, one of our usual cartons for packing our ice cream.

Mr. Kerr: I offer it in evidence as Marchiony pint carton.

(Marked Plaintiff's Exhibit 8 in evidence.)

The box shown me is a corrugated box insulated with corrugated board, and the ice cream is placed inside the box. [fol. 46] The ice is placed in the center of the box. This is one of the containers which we use in shipping our ice cream to various places. In the brown paper in the upper middle portion is solid carbon dioxide wrapped in wrapping paper. In this box the ice cream is placed in cartons similar to the one just offered in evidence.

Mr. Kerr: The box identified by the witness is offered in evidence as Plaintiff's Exhibit 9.

(Marked Plaintiff's Exhibit 9 in evidence.)

Mr.Kerr: We do not guarantee the ice cream will stay hard until the end of the suit.

The Court: Why don't you substitute a box of cartons and a wrapper of the same size as contains the solid carbon dioxide?

Mr. Kerr: May we consider this as such a package?

The Court: Yes.

We use a Balsa wood box for shipping our ice cream. This is such a box.

By the Court:

Q. That is for shipping long distances?

A. Shipping long distances.

Mr. Kerr: I offer in evidence the Balsa wood box as a physical exhibit.

(Marked Plaintiff's Exhibit 10 in evidence.)

[fol. 47] The drawing handed me correctly shows the way the ice cream and solid CO_2 are packed in our shipping cases. This is the way and method which we use in packing ice cream in the container.

Mr. Kerr: I offer the sketch in evidence as Plaintiff's Exhibit 11.

(Marked Plaintiff's Exhibit 11 in evidence.)

The sketch handed me of a box somewhat similar to the corrugated paper carton heretofore offered in evidence,

shows the way we use the refrigerant and the material refrigerated.

Mr. Kerr: I offer this in evidence as Plaintiff's Exhibit 12, illustration of Marchiony paper shipping carton.

(Marked Plaintiff's Exhibit 12 in evidence.)

In the drawing of the shipping case which has been handed me there is some separation of the ice cream from the sides and body of the box. This separation is made by wooden slats which are placed around this box so that the temperature will circulate and at other times corrugated board is placed around it so the corrugation of the board allows the refrigeration to circulate and keep the ice cream solid.

The purpose of the paper which is indicated as being wrapped around the solid CO_2 is to prevent it from evaporating too quickly.

The lids are secured on the Balsa wood boxes with steel strapping. We have been shipping our ice cream in these [fol. 48] containers such as the Balsa wood box offered in evidence and the corrugated paper container to about 20 different States, as far down as Texas, Maine, Minnesota, Chicago, Arkansas. These are regular shipments. For local shipping boxes we use the Balsa wood box as well as the corrugated box, or any other containers or paper boxes. We deliver with trucks and motorcycles. The motorcycle containers are insulated boxes, insulated bodies, insulated with cork, wood, or wool. In those motorcycles we place the ice cream around the boxes and place the dry ice in the center of it. We began using these various ways of packing and refrigerating ice cream about October, 1925, I believe. We first purchased solid carbon dioxide from the Dry Ice Corporation. Never before we began using it in October, 1925, I did not know of its existence and did not know how to use it. I found out because Mr. Cusack of the Dry Ice Corporation came to me, sold me the idea, told me how to ship it and how to pack it, and told me where to get the cartons and boxes. We have purchased solid carbon dioxide from the defendant in this case, the Carbice Corporation of America. The circumstances under which we purchase such solid carbon dioxide were these:

We were approched by Mr. Clark of the Carbice Company. The ice was offered to us at a lower price, therefore we found it to advantage to buy it from the Carbice Corporation, and we split the business between the Carbice and the Dry Ice.

The price at which they sold it to us I believe was 4½ cents. I believe we had some correspondence with the [fol. 49] Carbice Corporation at the time we began to buy solid carbon dioxide from them. The two letters handed me is correspondence had with the Carbice Corporation. One of these is a letter of March 15th which I sent to the Carbice Corporation, attention of Mr. Clark, and the other is a reply letter from Mr. Clark, dated March 18th.

Mr. Kerr: The letters identified by the witness are offered in evidence; the letter of March 15th is offered as Plaintiff's Exhibit 13, and the letter of March 18th is offered as Plantiff's Exhibit 14.

(Marked Plaintiff's Exhibits 13 and 14 in evidence.)

The person of the Carbice organization with whom I did business was Mr. Clark. We purchased solid carbon dioxide from the Carbice Corporation for about two months in 50 pounds, 75 and 25, quantities. At that time we used about 150 to 200, 125 and so on per day. Mr. Clark visited our plant in connection with getting these orders. I believe we discusesd the situation about the way you sold carbon dioxide. I have already stated how we were using solid carbon dioxide at the time Mr. Clark came to see us in March, 1927. While we were purchasing this solid carbon dioxide from the Carbice Corporation we used it as stated before, in the same manner and form and method. There was no change at all in the way we used the solid carbon dioxide purchased from the Carbice Corporation. There was no difference as contrasted with that [fol. 50] which we purchased from the Dry Ice Corporation. Mr. Clark visited our plant several times. Before we began using solid carbon dioxide as a refrigerant for shipping ice cream we used ice and salt. As to the difference in weight between a package using solid carbon dioxide and that using ice and salt with say a package contain-

ing about 50 pints the one with dry ice would be 75 pounds and the one with ice and salt about 200.

We could ship ice cream with water and salt refrigeration about 18 hours. Actually, as a matter of distance, we shipped it to Philadelphia or Boston. We did not make a business of shipping ice cream any distance. Now, the ice cream which we refrigerate with solid carbon dioxide remains in transit four or five days.

Q. With regard to your container for shipping ice cream packed with ice and salt, what was its form?

A. Pints and quarts.

Q. I am talking about shipments which you made when you shipped some distance, refrigerated with ice and salt, what the form was?

A. A wooden tub and a metal container. We had a wooden tub with the can in the center surrounded by crushed ice and salt. The use of solid CO_2 as a refrigerant in our business has been the means of shipping our product to long distances, and of course, we have increased our business since we began using the dry ice.

Cross-examination.

By Mr. Darby:

When we want to ship long distances we use a Balsa wood wood container. In other words, we can ship further with [fol. 51] Balsa wood than we can with cardboard. And that would be true no matter what kind of refrigerant you had there, it is a better insulator than cardboard, and it is stronger.

Q. And I think you also testified that when the dry ice people first interested you in using solid carbon dioxide they told you where you could get the cartons, and you did not change the place you were getting your ice cream cartons from, did you?

A. Yes, we did change. We got the ice cream cartons from a different place. A different printer made up our cartons at various times, depending on the price submitted and the quantities. The price and delivery was an important feature for us, and we changed the places we got the

outside cartons, depending on price and delivery. We do not get the consent of the Dry Ice Company each time we change the place where we get our ice cream cartons or outside cartons.

Redirect examination.

By Mr. Kerr:

Q. Just a question. I was not clear as to what you testified. In what sort of cartons did you sell your ice cream prior to using dry ice?

The Court: He said wooden tubs and metal containers.
Mr. Kerr: That was for long distance shipments.

A. We packed our product in paper cartons. It was packed into paper outside cartons, not for shipping, just [fol. 52] a matter of manufacture and producing it. They were refrigerated with ice and salt.

Q. And what sort of containers did you have then?

A. Tubs and ice cream cabinets, tubs and tanks.

(Witness excused.)

Walter E. Ditmars, called as a witness on behalf of the plaintiff, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

I received the original of the letter from George C. Dean to me dated October 27, 1926.

Mr. Kerr: The letter from Mr. Dean to Mr. Ditmars of October 27, 1926, is offered in evidence as Plaintiff's Exhibit 15.

(Marked Plaintiff's Exhibit 15 in evidence.)

Q. I hand you herewith the December 21st copy of "Electric Refrigeration News," which has an article on "Applications of Carbon Ice Explained," and the editor's note

attributes the article to you as being delivered at a meeting of the Eastern Ice Association, November 29th to December 1st. I will ask you if that is a correct report of your remarks?

A. That is part of it, not all of it.

[fol. 53] Q. In so far as it is in that paper is that a true transcript?

A. Essentially correct.

Mr. Kerr: The paper, a copy of Electric Refrigeration News, of December 21st, is offered in evidence.

Mr. Darby: I object to it, because I do not know what pertinency it has to any issue here.

The Court: I do not know anything about it. Look at it.

Mr. Darby: If Mr. Kerr will tell its purpose or relevancy, I might not have objection.

Mr. Kerr: I think the article which was given by Mr. Ditmars, who for a time at least was the president of the Carbice Corporation, is very good evidence both of the novelty and of the utility of these containers in question.

The Court: All right, we will take it.

Mr. Darby: I would like to record my objection. I do not know what part it will play, but I object to it as incompetent, irrelevant and immaterial.

The Court: I suppose it is offered as a sort of admission on the part of the defendant through its principal officer.

Mr. Darby: He was not the principal officer. He was not connected with the company as I understand, at the time the article was written. The article was not written by him. It is somebody's expression.

The Court: He said it is a fair statement of what he said.

[fol. 54] Mr. Darby: Of part of what he said. It is not complete.

The Court: He can supply the rest of it if he has it.

Dr. Darby: I do not know if he kept his speech or not.

The Court: I will take it.

(Marked Plaintiff's Exhibit 16 in evidence.)

Q. Mr. Ditmars, I hand you herewith a two-page folder, which is an advertising sheet similar to that which appeared in the Ice Cream Trade Journal of May, 1927. Was that put out by the Carbice Company?

A. Yes, sir.

Mr. Kerr: The folder is offered in evidence.

Mr. Darby: The same objection. It has no bearing on the issues. It merely shows we were in business, and we admit that.

Mr. Kerr: It is your advertisement. You are advertising your product. If your product is an infringing product——

Mr. Darby: My objection went to the relevancy on the issue in this case.

The Court: I will take it.

(Marked Plaintiff's Exhibit 17 in evidence.)

I was president of the Carbice Corporation of America for about a year. From about July, 1926, until September, 1927, I was president. From then on I was executive manager of the Carbice Corporation, and president of the Solid [fol. 55] Carbonic Company. I am now president of the Solid Carbonic Company.

Q. That company is defending this suit?

A. The suit is between the Carbice Corporation and the Dry Ice Corporation.

The Court: That is not what he asked you. He asked you if your company is defending the suit; are you paying the expenses of counsel and the expenses of the defense? That is what he is asking you to make plain.

Mr. Kerr: That statement has been made to me.

The Court: He is asked a question now. Let him answer first.

A. Well, we put up the money. The Solid Carbonic Company owns at least 51 per cent. of the stock of the Carbice Company.

Q. I hand you herewith a copy of a stock circular issued by Harvey Fisk & Sons, which quotes quite extensively from a supposed letter of yours. Will you please refer to this and state whether you wrote such a letter, and whether it is correctly set out in that circular?

The Court: What is all this to show?

Mr. Kerr: I simply want to make perfectly clear the connection between the two companies.

The Court: What difference does it make? He says his company is defending the suit, paying the defense. Why go further.

Mr. Darby: I think that answer makes this case res ad-
[fol. 56] judicata with respect to both parties.

The Court: I do not see that you need to go into a lot of stock deals. We have the answer of the witness that his company is paying the money to defend this case. I apprehend that is the principal part of the defense.

Mr. Kerr: This letter emphasizes the importance of the industry and extent of the business. It seems it goes to the question of the utility of the invention.

The Court: I will take it for that, but if I do not think so, I will strike it out.

Mr. Darby: I record an objection.

The Court: Yes, I will take it and see.

(Marked Plaintiff's Exhibit 18 in evidence.)

Mr. Kerr: That is all.

Cross-examination.

By Mr. Darby:

I have testified that I became president of the Carbice Corporation and that company was engaged in manufacturing solid carbon dioxide.

Q. Did you just arbitrarily go into this business, or did you consult counsel to determine whether or not in the opinion of counsel, rightly or wrongly, it was legitimate for you to engage in such business?

A. Yes, we did.

Mr. Kerr: I object to their going into their own case now.

The Court: That is true. You are not cross examining on anything brought out in the examination in chief.

[fol. 57] Mr. Darby: I intended to bring it in. I thought Mr. Kerr brought in the question of his going into business.

The Court: He asked him when and where and he did not ask any question about how.

Mr. Darby: If "when" and "where" does not open "how," then your Honor is right.

The Court: I think not. "How" has something different attached to it.

Mr. Kerr: I shall offer in evidence notice of an infringement dated April 16, 1927, to Carbice Company.

(Marked Plaintiff's Exhibit 20 in evidence.)

Mr. Kerr: I have finished with my fact witnesses and I would like to put Mr. Schwarz on for a short deposition.

The Court: All right.

ELMER H. SCHWARZ, called as a witness on behalf of the plaintiff, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

My age is 48, I am a consulting engineer in New York City. I reside in Englewood, New Jersey.

I graduated in 1901 from the Sheffield Scientific School at New Haven, Connecticut. This is the Scientific Depart- [fol. 58] ment of Yale University. My course was rather comprehensive, including chemistry, physics, the theory of heat, heat engines and experimental and applied sciences. I specialized in electrical and mechanical engineering. Since graduation I have been following my engineering profession, and since 1911, as a consulting engineer in New York City, and I act in a consulting capacity for a number of manufacturing concerns. For the most part my work has related to new developments, patents and inventions, particularly in connection with suits for infringement of patents litigated in the Federal courts. I have acted in many suits as a patent and practical expert in patent litigation before the Federal courts. During the last several years I have devoted considerable time to the study of the physics of gases and have carried on some experiments with those gases. Since about 1920 I have been more or less actively interested in mechanical refrigeration. That was about the time that the household refrigerator worked by compressors and motors with various gases became popular. In this particular matter of refrigeration by solid CO_2 I was retained by the plaintiff company soon after the suit was started last May, and I have made quite a close study of the subject since then, and have conducted some experiments and been present at others, and have read considerably on the subject. I am a member of a number of national engineering societies, the Society of Automotive Engineers, the American Society of Mechanical Engineers,

the American Institute of Electrical Engineers, and am also [fol. 59] a licensed professional engineer of the State of New York.

I have read and understand the Slate patent in suit.

The patent relates to refrigeration by means of solid carbon dioxide, of an insulated transportable package or a shipping case containing perishable products, preferably such as it is desired to keep very cold and to preserve from the atmosphere, particularly such as are not damaged by temperatures, far below freezing, for instance, yeast, ice cream, or hard frozen products. The CO_2 is preferably highly compressed CO_2 snow or frozen liquid CO_2. Referring to the drawing sheet, 20 is the shipping box in which is contained the perishable products 27, which, for example, may be a number of pint or quart cartons of ice cream arranged in layers, and three of such layers are shown in the patent. At the center of the middle layer is shown the solid carbon dioxide container, 22, the detail of which is seen in Fig. 2. As illustrated, the containers 20 and 22 are made of insulating material. It will thus be seen that the solid carbon dioxide is in or among the mass or perishable products whereby certain portions of the products are in close proximity to this intense refrigerant, that is, those directly adjacent to the carbon dioxide, while other portions are relatively remote, as for instance, those near or in contact with the outer walls of the shipping box or container. The patent points out that the products close to and particularly those in contact with the carbon dioxide container will be reduced to temperatures far below parts of the mass that [fol. 60] are more remote. The patent further points out by placing the solid carbon dioxide in the midst of the products to be shipped it will slowly and gradually refrigerate those products by the gas generated by the carbon dioxide and will continuously keep the air and moisture in the shipping case displaced. The refrigerating action is thus two-fold: first, by direct conduction of the heat from the products directly adjacent to the solid carbon dioxide, and second, by convection through the absorption of heat by the CO_2 gas generated from the solid CO_2, and which convection currents reach not only that part of the refrigerated product which is directly adjacent to the solid CO_2, but also more remote portions of the product. This ar-

rangement also has the advantage that the refrigerant is insulated from the outside air not only by the insulating walls of the package and the gas within it, but also by the refrigerated mass about it. When heat is absorbed by the solid CO_2, CO_2 gas is immediately generated. There is no intermediate stage in which the liquid CO_2 is formed, and in that respect it differs from ordinary ice. On this account the package is sanitary and free from moisture, and there is no spilling out of liquid as there is in water ice. That direct conversion of the solid CO_2 to gas instead of being melted into a liquid is known as sublimation. This gas that is formed by the warming up of the CO_2 ice is heavier than air. It is about 1½ times the weight of the same quantity of air. As the new gas is generated the older gas, after absorbing heat from the atmosphere of the container and [fol. 61] from the refrigerated product, travels upward, a layer of it flowing along the side walls of the container, 20. In so doing it displaces the air and moisture in the box, as the patent states, and carries along with it any heat which might pass through the walls of the container 20. The plenum of pressure within the box, due to the generation of gas therein, naturally tends to repel any air which might otherwise enter the case from the outside through the pores of the container, or through cracks or openings between the case and its cover. In fact, the CO_2 gas would force itself outward into the pores of the walls of the container, and in that respect the fight to prevent the entry of heat is really carried into the walls of the container itself. After the case becomes filled with CO_2 gas, partially warmed, this gas escapes to the atmosphere under the cover on the top of the casing or through a vent. Thus we see that the CO_2 gas generated from the solid form not only acts as an additional refrigerant due to its low temperature, which is in the ne-ghborhood of minus 110 degrees Fahrenheit, but it cools the products throughout the entire container, due to its travel to all parts of the box, and it also forms an insulating envelope around the walls of the container, 20, and prevents any considerable heat or warm air from entering the container from the outside. In this connection, and independently of its temperature, CO_2 gas has about twice the insulating value of that of air. Stated in another way, it is about twice as hard for heat to pass through CO_2 gas as it is to pass through air.

[fol. 62] The additional value of the gas is the part it plays as a scavenger agent in carrying along with it upward and out of the package under the cover or through the side walls whatever heat it absorbs within the container and along the walls.

I might say at this point that the gas is continuously generated, and is continuously let out of the box, and there is no continuous circulation of the same gas around and around like there is a circulation of air around the ordinary ice box. That is, the air is excluded and gas fills the entire inside of the container and is continuously released through a vent, or escapes through the cracks and openings.

To sum up, we see that Slate uses the solid CO_2 as a generator of gas and that not only does the solid CO_2 itself refrigerate by direct conduction, but that an atmosphere mainly of cold CO_2 gas is created within the casing, displacing the air therein and insulating the products within the container from outside influence. By well insulating the container 20, and properly insulating or shielding the solid CO_2, which can be also shielded by the articles around it, external heat is not easily accessible to the CO_2, and the rate of evaporation is, therefore, held in check, and in this way intense refrigeration is afforded for a long period of time.

Referring to the drawings of the Marchiony shipping case and cartons, Exhibits 11 and 12, and to Mr. Marchiony's testimony given in court here this morning, I find the invention of the patent in suit embodied in both of these forms shown on Exhibits 11 and 12 which you have handed [fol. 63] me. These are ice cream packages consisting of insulated containers in which are packed a number of packages of ice cream in individual cartons, and substantially in the middle of the same, and surrounded by the ice cream packages is the solid CO_2, which is insulated. The outside container itself is made of insulated material.

By this means of shipment of the ice cream the ice cream packages directly adjacent to the solid CO_2 are more intensely refrigerated than those near the walls of the container, and by this method of packing, as the CO_2 melted the gas is generated from it, descends to the bottom of the container, and passes around the individual packages and then travels upward and distributes itself around and between

the other packages that are more remote, and it also causes to form an insulating envelope of gas around the material and around the inside of the container. The gas by this construction is permitted, as it passes upward and becomes warmed, to pass under the cover of the container or through the pores or cracks and out to the atmosphere. The slight pressure generated by the gas causes the heat to be repelled that might enter through the pores of the container, and the gas scavenges out of the container any heat that forms in the container or any heat that is in the container which comes from the container itself or from the material therein. The gas generated in these two types of packages displaces the air and moisture within the container and increases the refrigerating effect.

[fol. 64] The best information that I have as to the amount of gas which is given off from say a pound of solid CO_2, is for every pound of solid CO_2 that is sublimed about 8½, or between 8 and 9 cubic feet of gas, is or are formed, that is, at atmospheric pressure.

Mr. Kerr: Direct examination closed.

Cross-examination by Mr. Darby:

Q. If I put a cake of ice in the middle of a number of individual units to be refrigerated—in other words, referring to Fig. 1 of the drawing, leaving everything else the same, and I put water ice in place of the solid carbon dioxide—in the solid carbon dioxide container, 22, of Fig. 1 of the patent in suit, the individual elements that are being refrigerated next to that ice are going to be colder than the remote elements, are they not?

A. The chances are the ice cream would be much colder than the ice——

Q. I am not asking you about the ice cream. Take anything.

A. That would not be true, because the ice cream itself is colder than the ice.

Q. I am not asking about ice cream. Say there are a number of elements to be refrigerated, element 57, and instead of putting solid carbon dioxide in the container 22, I put water ice, let us assume that at the start these elements are warmer than the water ice, now my question is which would get the colder, these elements next to the ice con-

tainer, or the ones further away?

A. Certainly the ones next to the container would be colder, but none of them would be frozen.

[fol. 65] Q. Of course not. I think you mentioned the fact that carbon dioxide does not sublime.

A. A. I said it did sublime.

Q. Pardon me, that is correct. It goes directly from the solid state into the gasous estate without passing through the liquid state?

A. At atmospheric pressure.

Q. In other words, the pressure is a controlling factor?

A. Yes, sir.

Q. It would be possible by controlling the pressure for the solid carbon dioxide to go into the liquid state, wouldn't it?

A. That is possible, but not for this kind of refrigeration, of course.

Q. I am not referring to refrigeration at all. About at what pressure would solid carbon dioxide go into the liquid state rather than the gaseous state?

A. I think the pressure would be around 50 pounds per square inch. I am not positive of that, Mr. Darby.

Q. Water ice can be sublimed too, can't it?

A. I would have to think that over. I do not know what the triple point is.

Q. Are you at all familiar with the fish storage industry?

A. Not particularly. I have heard about the use of dry ice in connection with the shipment of fish.

Q. You have not heard anything of the use of water ice?

A. Yes, sir.

Q. For the shipment of fish?

A. Yes, sir.

Q. And for the storage of fish?

A. I do not know a whole lot about that particular phase of it.

Q. At atmospheric pressure do you know whether or not water ice can be sublimed?

A. I do not think it can at atmospheric pressure.

[fol. 66] Q. You do not think it can?

A. I do not see how it could.

Q. There are two elements that control whether or not material is sublimed, that is pressure and temperature?

A. Yes, sir.

Q. Suppose you take ordinary water ice and get the temperature down to around 15 degrees and keep it there, do you suppose there would be any subliming action?

A. Not at atmospheric pressure.

Q. Not at atmospheric pressure; all right.

A. I do not see how there could be.

(Witness excused.)

Mr. Kerr: That is our case, your Honor.

Mr. Darby: I will offer in evidence copy of the original patent No. 1,511,306, from which the patent in suit is divided, that is a certified copy of the file wrapper and contents.

(Marked Defendant's Exhibit A in evidence.)

Mr. Darby: I offer in evidence certified copy of the file wrapper and contents of the patent in suit, No. 1,595,426.

(Marked Defendant's Exhibit B in evidence.)

Recess till 2 P. M.

[fol. 67] Met pursuant to adjournment at 2 P. M., present as before.

JOHN E. STARR, called as a witness on behalf of the defendant, being duly s-orn, testified as follows:

Direct examination.

By Mr. Darby:

I reside at 47 Fifth Ayenue, New York City. I am a mechanical engineer, physicist. I have been associated with the refrigerating industry for approximately 35 years. I have designed and operated machinery for the production of refrigeration, and in the course of that work I have used a great many fluids, in the gaseous, liquid and solid state, and have had to, in the course of my profession, become acquainted with all methods of refrigeration. Also in this connection I have written books on the subject of refrigera-

tion, and contributed more or less to the technical press on subjects connected with refrigeration, liquefaction and solidification of gases, and as an auxiliary to that I have found it desirable to join certain scientific societies and organizations connected with the refrigeration of the liquefaction and solidification of gases, such as the American Society of Refrigerating Engineers, the American Society of Mechanical Engineers, the American Association of Refrigeration, the International Association of Refrigeration, I was a delegate in behalf of the United States to the International Congress of Refrigeration in 1893, and have found [fol. 68] it desirable to become connected with other scientific organizations, and with those connected with refrigeration, and in the course of such organization, and from other reading, I have attempted to post myself fully on the subject of refrigeration, liquefaction, and solidification of gases.

I am a past President of the American Society of Refrigerating Engineers.

I have acted as consulting engineer for a great many companies in the refrigerating industry. It would be difficult to enumerate them all here. I cannot remember them. But I have been directly associated, I think first with the St. Louis Automatic Refrigerating Company. That was back in the eighteen nineties, and I have from that time on acted largely as consulting engineer for a large number of companies throughout the United States, both storage warehouse companies, ice manufacturing companies, and in general consultation in regard to the liquefaction and solidification of gases, and of late most of my time has been occupied as consulting engineer for the American Ice Company, or Knickerbocker Ice Company, and their branches.

I think I may say during the past 35 years I have come in personal contact with possibly all the known forms of refrigeration, such as refrigeration by the evaporation of liquids to a gas, solids to a liquid, solids to a gas, refrigeration by means of the so-called Frigurific solutions, refrigeration by what are known as evaporative processes, that is, a common example of that would be in the water tower, which is used universally throughout the city where water is cooled by its own evaporation, and by use of an ab-

[fol. 69] sorbent, such as silica gel, water, sulphuric acid, and other absorbents.

Q. Specifically can you give us the specific names of refrigerating material, illustrating each of the types of refrigeration that you just enumerated, and in which you have come in personal contact?

A. I suppose the largest fluid I have come in contact with for refrigerating purposes is ammonia, which is used universally throughout the United States, throughout the country. Next to that I suppose CO_2, carbonic acid, or carbon dioxide. I have used mostly for refrigerating purposes next to ammonia, chloride of ethyl, chloride of methyl, sulphur dioxide, butane, iso-butane, propane, sulphur bisulphide, water, alcohol, carbon tetrachloride, and two or three others I do not recall at the present moment. I have, of course been familiar with water ice.

I have been familiar with the use of carbon dioxide as a refrigerant since about 1900, it may be 1898, or may be 1901 or 1902. I cannot remember quite the date.

Q. In what form of carbon dioxide have you been familiar with it as a refrigerant?

A. I have used it more in a liquid form than in any other, but I have been familiar with it, and have used it in starting with its solid condition, solid form, carbon dioxide snow. Such, for example, as the material here, excepted not compacted quite as much as that, not quite in such a compact shape.

The Court: It did not exert the same compression?

[fol. 70] The Witness: Not the same compression, less weight and solid than that.

Q. Under what circumstances did you first become familiar with the use of solid carbon dioxide as a refrigerant?

A. I think my first personal use of it—of course, I knew the use of it; that was used probably since 1887, but my first personal use of it was in testing the commercial value of its use against another refrigerating process.

At that time, which was sometime prior to 1900, certainly not later than 1901, I was operating a method of refrigeration in St. Louis known as the Fountain and Absorber system. That was a system by which a fountain or

drum of ammonia was placed beside a refrigerator and the usual piping placed inside the refrigerator for evaporating the ammonia, and the ammonia would then be caught and run into another absorber, as we called it, which contained water, and that water would absorb the gaseous water and make a strong solution of ammonia and water, and that solution would be taken back to the factory and the ammonia driven out of it and reliquefied, and the reliquefied ammonia would again be placed in cylinders and fountains and used over again in the same way as I have described. In that system of refrigeration which was used at that time in competition with the prevailing system of ice refrigeration we were able to produce temperatures of about in the neighborhood of 20 below zero, which was the boiling point of liquid ammonia at atmospheric pressure, and in that [fol. 71] way we refrigerated all kinds of refrigerators, large and small boxes, and sometime during the period of which I speak a doctor in one of the St. Louis hospitals came to me and asked if a way could be suggested or produced of freezing tissues, human tissues, or animal tissues, so that thin slices of them could be made for the purpose of making microscopic slides—to freeze it so hard a very thin slice could be made of it. He stated to me that he would require a very low temperature for that, it would have to be freezing very hard indeed, and it immediately occurred to me, knowing what could be done with solid carbon dioxide, and what had been done with it, the first thing that suggested itself to me was to use carbon dioxide solid, because I knew very low temperatures could be obtained by that. I made some solid carbon dioxide like this and used it in the usual way that refrigerants are used to produce a very low temperature in the small box, refrigerator, which was insulated in the usual way that all refrigerators were insulated, and it was done simply by placing some of this solid dioxide in the box and placing the tissues to be frozen in close proximity to it in the box, or freezing proximity to it. The temperature that was produced in the material to be frozen was, of course, the part nearest to the CO_2, where the temperature was very low. A little ways off it was a little bit higher, but there was no temperature in the refrigerator much higher than 40 below

zero. This, of course, accomplished the desired object, that is to say, it froze the tissues very hard and in shape so he could use them.

[fol. 72] Q. What was the approximate size of that box?

A. That box was a cylinder about 9 inches in diameter and about 2 feet long, and a matter of 2 or 3 cubic feet, I suppose, insulated with, in that case, hair felt wrapped around the outside and boxed in to make it look neat. It was the same kind of an apparatus, the same kind of a refrigerator that I used for the fountain absorber system, in finding how much work could be done by the carbon dioxide—there was no question of its doing the work, but simply a question of how much it would take in proportion, and what the cost would be in proportion to doing the same refrigeration the other way, that is, the ammonia fountain and absorber system, and knowing we would get very low temperatures with the ammonia system I froze some more material with the ammonia method, and the doctor told me that was frozen low enough and hard enough, and therefore it was simply a matter of which was the cheaper and most convenient. As we were furnishing refrigeration at that time with the fountain and absorber system at about the prices of the prevailing ice market, of course, it was found with the carbon dioxide the system would cost a little more money, and as both could be done in the same apparatus we naturally decided on using the fountain and absorber system, and it was used for, I guess, two or three years after that. We could have used the carbon dioxide system method just as well, and perhaps it would have been a little more effective, but it would cost more, that is all.

Mr. Kerr: Your Honor, if I may be allowed to interpose [fol. 73] an objection to this so-called carbon dioxide prior use; it occurred 30 years ago, obviously was tried once, and then was given up; I do not think Mr. Starr, in the first place, has any records or anything to corroborate his testimony.

The Court: All right, he is giving his testimony.

Mr. Kerr: I just wanted to make a formal objection at this time.

The Court: All right. It goes to the weight. You don't have to object to the weight. That will be considered.

Q. Then as I understand you, after you froze the tissue with solid carbon dioxide you froze some more of the tissue with the fountain and absorber system?

A. Yes, sir.

Q. And you found that the tissue frozen by the fountain and absorber system was sufficiently frozen for the uses of this particular doctor?

A. Yes, sir.

Q. And that by a comparison of economy the fountain absorber system was more economical than the carbon dioxide system?

A. Yes.

The name of this doctor was Dr. Bransford Lewis. I think he is dead.

Q. After you completed the freezing of the tissue with the solid carbon dioxide in this box or refrigerator, as you have called it, what did you do with it?

A. I used the box on the fountain and absorber system. I did not deliver the material or the tissue to Dr. Lewis for his inspection. I delivered him the apparatus. In the first place, I sent over to him the apparatus using carbon di- [fol. 74] oxide. It already had the carbon dioxide in it when I sent it over to him, and was chilled and cooled, and was cool at the time it reached him. That was sent across the city two or three miles in a truck. We put the box in a truck and sent it to him while it was under refrigeration. I have some written data pertaining to these tests. I forgot to bring them over this morning. I have them in my office. I will be sure to bring them over with me Monday morning.

I have stated that at this time that I made this comparative test that I knew of the prior use of solid carbon dioxide. I base this knowledge on my general knowledge, reading, and the general knowledge on the subject which existed in the scientific literature of that day. I kept posted on that, of course.

Mr. Kerr: I object to this testimony unless he can produce his authorities as to where he got his knowledge from.

Mr. Darby: I am going to, they are right here; I am leading up to it.

The Court: He is leading him up to it.

Q. Can you refer me specifically to any authorities that you were familiar with at that time?

A. I do not think I can particularize at this time. I can remember and cite authorities a little bit later, probably along about 1906 or 1907. I can cite particular authorities. I do not know just what they were at that time. It was a matter of general reading. I was subscriber to the Magazine "Ice and Refrigeration", and kept posted with the [fol. 75] articles that appeared in that. I was also possessed of the publication "Liquid Air" by Sloan, a little bit later than 1900. That book "Liquid Air and Liquefaction of Gases," by Sloan, was one of the books of my library.

Mr. Kerr: That is objected to; it is not set up as an anticipation.

The Court: You asked what authority he had for his understanding.

Mr. Kerr: If it is relied on as an anticipation, I object.

The Court: This is the general state of the art, common knowledge, I understood, at that time by most of those in the art, and he is giving the authorities as you asked him to.

These books are my bound copies from my library from the magazine "Ice and Refrigeration." I have had them in my possession since they were issued, the dates of their issuance.

Q. I call your attention (I suppose it was bound at one time) to this bound Volume I, September, 1891. Were you familiar with this article by August J. Rossi, found on page 141, entitled "Artificial Refrigeration"?

A. Yes, sir.

Mr. Darby: I offer in evidence from this bound volume the article by August J. Rossi entitled "Artificial Refrigeration", found on page 141 to 143; likewise an article immediately following, entitled "New Refrigerants"; and in the same bound volume an article entitled "Low Temperature", found on page 425 in the issue of June, 1892; and [fol. 76] in the same bound volume in the issue of July, 1892, an article entitled "Production of Extremely Low Temperatures", by August J. Rossi, pages 30 to 32 inclusive; and in the same bound volume an article by the same

author, entitled "Production of Extremely Low Temperature", issue of August, 1892, pages 98 and 99.

Mr. Kerr: Your Honor, I have not seen these, so I am in no position to offer any objection to them at the present time, but I understand they are offered solely as showing the state of the art and not as anticipation.

Mr. Darby: That is right.

The Court: Are you going to substitute photostat copies?

Mr. Darby: I would like to.

Mr. Kerr: And give us copies?

Mr. Darby: Yes, sir, I would like to contine my offer of the other bound volumes. I offer on page 350-D of the issue of May, 1895, the abstract of a patent No. 533,794, "Refrigerator Shipping Box."

Mr. Kerr: It seems to me the patent speaks best for itself, and not the comment.

Mr. Darby: This is not a comment, it is a reproduction of a figure of the drawing and a reproduction of the Claim 1 of the patent. I hope to have the patent here. It is a [fol. 77] publication in this journal, and is offered in any event. Likewise I offer "Solid Carbonic Acid", on page 180, September, 1895; likewise an article, January, 1893, entitled "Liquefaction of Gases by Vaughn Cornish", contained on pages 18, 19, 20 and 21. Likewise in the issue of April, 1893, page 306, the extract from patent No. 490,955, Refrigerator; likewise from "Liquid Air," by Sloan, a publication of 1900, from Chapter I, pages 15 and 16, pages 90 and 91.

(Photostats of the above offers are to be bound in one volume and marked in evidence as Defendant's Exhibit C in evidence.)

Q. Did you have any other personal experience with solid carbon dioxide as a refrigerant?

A. Along about 1905, within a year or two of that date, I tested the commercial value of the use of solid carbon dioxide against the use of solid water, or water ice, as we usually call it, in a refrigerator, knowing at the time that either of the solids could be used for refrigerating purposes, but desiring to ascertain more particularly the relative commercial value of each process. That was occasioned by the result of an investigation I had to make in Chicago in

the interest of Mr. Hugh Grant. That is the way I partially fix the date, it must have been before the death of Mr. Hugh Grant. Mr. Hugh Grant was Mayor of New York at one time, and he died in about 1910 or 1911, I think, and this must have been certainly before his death. A gentleman in Chicago named Osborne had proposed a system of [fol. 78] refrigeration by the use of carbon dioxide by separating the carbon dioxide out of flue gases, that is, in manufacturing plants and other places where coal was burned there was of course large quantities of carbon dioxide generated in combustion, and his proposition was to separate this carbon dioxide out of these flue gases and liquefy it and send it around through the streets of the city in piping, so it could be used in refrigerators in the usual way, such as fluids are used in piping, placed in refrigerators, and then the resulting gas allowed to escape in the atmosphere.

Mr. Osborne made some statements in regard to the refrigerating value of carbon dioxide, that is, as to the amount of heat it would take up in evaporating that did not seem quite in accordance with the accumulated knowledge up to that date on the subject, but it was stated in a way that it was somewhat puzzling, and while at that time I rejected his method as being impracticable, and too costly, I was inclined to pay some attention to what seemed to me his rather extraordinary claims as to the value as a refrigerant, and while I turned down his system to Mr. Grant, and while I did not believe at that time that carbon dioxide would prove cheaper than water ice, I was willing to try it, so we made a test of this dry ice and water ice by using two refrigerators of exactly the same construction side by side and using water ice in one, and the so-called dry ice in the other. We desired to get temperatures with the dry ice the practical equivalents of temperatures that could be obtained by water ice. Water ice in the [fol. 79] refrigerator would not give us much below 40 or 50 in the refrigerator. It was, therefore, necessary to insulate the dry ice placed in the refrigerator by placing a light insulation around it so it would not take up heat too rapidly and produce too cold a temperature, and would obtain a temperature practically equivalent to the temperature obtained by water ice. I made one test of that and found that by putting the dry ice in a bag it still gave too low a

temperature in the box, that is, it took up heat too rapidly, so we put that bag in another bag and so insulated the dry ice that we were able to maintain the temperature of not much below 4 in the refrigerator, which was approximately the same temperature that could be obtained by ice, and then I carefully measured the amount of water ice used and the amount of dry ice used in doing the same amount of work, producing the same kind of refrigeration, or, in other words, keeping the same temperature in the box, the same for some length of time. The market cost of water ice being known, and some approximation of the probable cost of the other ice could be made, I was able to make a comparison of the cost of doing a certain amount of refrigeration one way and doing it the other way. For ordinary refrigerating purposes the cost of the dry ice seemed so very much in excess of the cost of doing the same work with water ice that it led to the conclusion that for that purpose water ice would be more expedient and the better thing to use, the more practical thing to use commercially. There was no question as to either one or the other pro- [fol. 80] ducing refrigeration in the same way and for the same reasons.

Q. Have you endeavored to locate the copies of your reports?

A. I have, and they are in the same condition as the other memorandum. I forgot to bring them over this morning. I do not think that any of the people who were associated with me in that investigation of those tests are alive today.

Q. You have heard the testimony of Mr. Schwarz concerning the fact that this solid carbon dioxide evolves gas while it absorbs heat, and that that gas forms an insulation between the outside atmosphere and the solid carbon dioxide?

A. I have heard that testimony. That is a phenomena which is peculiar to solid carbon dioxide as distinguished from other refrigerants.

Q. In what way is that?

A. That carbon dioxide when it passes into gas is surrounded by a layer of its own gas, and that layer of gas will obstruct the passage of heat, and it may be regarded as an additional insulation to the insulation that was put in the box originally; simply an addition to the insulation of the refrigerator.

Q. Is that fact inherent to solid carbon dioxide, in other words, can you avoid that in using solid carbon dioxide under atmospheric conditions?

A. I do not quite understand the question. You cannot avoid it. It is unavoidable. It is something that would unavoidably happen.

The Court: Then it is inherent in the gas itself?

[fol. 81] The Witness: It is inherent in the change from solid to a gas. The gas has to go somewhere. Naturally, it surrounds the solid.

Q. Does that phenomena take place with any other type of refrigerant that you are familiar with?

A. It would depend on the way it was used. It might take place certainly with anyone. If you put a liquid in a closed box, and the liquid evaporated, it would fill the box with the gases of that liquid just the same as this would fill it with gases of carbon dioxide. Any liquid would do the same thing.

Q. As I understand it, the insulation, whether it be gas or some other material, is a body of gas or other material which obstructs the flow of heat waves through it, is that correct?

A. Yes, that is correct.

Mr. Kerr: It seems to me these questions are pretty leading.

Mr. Darby: All right, I will stop.

Q. In what respect, if at all, does a vacuum type of insulation differ from a gas or solid body type of insulation or semi-solid body type of insulation?

A. The usual type of gaseous or solid insulation is to obstruct the flow of heat from a cold body to a warm one. A vacuum does not obstruct the flow of heat, but the flow is interrupted between the warm body and the cold one, because if there is a reflected surface next the vacuum which will reflect the ray of heat back, and there being a [fol. 82] vacuum there, there is nothing to hold the heat, so the heat will be thrown back to where it came from, a good part of it, not all of it. Heat waves can be reflected just like light waves, that is the reason most Thermos vacuum bottles are coated with a silver coating.

I heard Mr. Schwarz testify he does not believe water can be sublimed. I do not agree with that.

The Court: I think he limited that. At atmospheric pressure, he said.

The Witness: Yes, sir, it can be sublimed at atmospheric pressure.

It is being done commercially practically. If the combination of pressure and temperature is proper, of course it can sublime, answering the general physical laws for the same reason the carbon dioxide sublimes. There is no difference in the reason, except a difference in the conditions of temperature and pressure. Ice at a lower temperature than at its melting point, 32, will sublime. It is affected by heat, only not so much as when above 32, but it will sublime and pass from a solid to a gas, and under some conditions it will be observed in doing it in very large quantities, tons, I mean, not pounds, or grams, but tons; for instance, in large fishery establishments it is the practice to coat a block of fish with a coating of ice. The fish is frozen at a low temperature, and that temperature is so low when that fish is run through a tub of ice water, the [fol. 83] temperature of the fish is so low it will accumulate a glaze of ice covering the whole block of fish. If that fish is put in storage rooms, they are generally piled up in stacks like cordwood in storage rooms, a great many tons of them, and from the very moment that those fish are put in the storage room, held at a temperature of say 10 or 15 in their atmospheric pressure, the ice commences to sublime, or leave the surface of the fish, and disappear. That is so rapid that it has to be renewed from time to time, that is, the fish, as they say, have to be re-dipped, that is, they have to be run through the water again so as to accumulate another glaze of ice to replace the glaze of ice that has disappeared or sublimed. That goes on in large establishments. I can remember one case where they sublimed about at the rate of two tons a week. I have been familiar with subliming of water ice at atmospheric pressure I suppose since I first knew anything about refrigeration. It is one of the first things one's attention naturally brought to in studying the question of refrigeration.

I heard Mr. Schwarz's testimony to the effect that employing solid carbon dioxide in an arrangement where the

refrigerant is in the center, and it is surrounded by the things to be refrigerated, that the material immediately adjacent the refrigerant is colder than the material at the remote point. There is nothing peculiar to solid carbon dioxide in that respect. Anything that is near a cold body will, of course, become colder than something that is further away from it, as heat is always passing from a warm body toward a cold body.

[fol. 84] I am familiar with the use of methyl chloride as a refrigerant.

Q. If in place of employing solid carbon dioxide in this central compartment surrounded by the parts to be refrigerated we employ methyl chloride in liquid form, what happens to the methyl chloride as it absorbs heat?

A. It evaporates. It changes to a gas. In that position which you indicate the gas would pass out of the box through the interstices between the goods stored in the box, just the same way as in the case described in the case of sublimation of gas in carbon dioxide.

Q. Is there any other refrigerant you have experience with in which the action would be the same?

A. Any of them would. Any refrigerant that would be changed to a gas by heat.

The Court: Do you want to defer his cross-examination until you get the notes?

Mr. Kerr: I would prefer to do that, your Honor.

The Court: All right. If you bring your notes with you Monday, Mr. Kerr will then cross-examine you and make it entire.

(Witness excused.)

[fol. 85] Jesse B. Churchill, called as a witness on behalf of the defendant, being duly sworn, testified as follows:

Direct examination.

By Mr. Darby:

My home residence is at Plimpton, Mass. I spend a great deal of time in New York, and my residence when in New

York is at the Chemists' Club, 52 East 41st Street. My occupation is that of chemist.

Q. Please briefly state your education and experience in chemistry, and particularly with respect to refrigeration.

The Court: He is not called as an expert, is he? You can only have one.

Mr. Darby: No, sir; this is a fact witness. I have not called an expert yet at all.

The Court: I thought the last witness was the expert.

Mr. Darby: I am not going into expert testimony in the sense of a patent expert. I am not going to put in testimony to that effect. I am going to put in the patents.

The Court: You are not going to have anybody to testify to patents, you are just going to let them speak for themselves?

Mr. Darby: Yes; as we view the case the patent is for a container. We do not need an expert for that.

A. I received my early training at Harvard University. In 1900 I went as assistant, or instructor, to be exact, to [fol. 86] Pennsylvania State College, Department of Chemistry, where I continued in various ranks or positions from instructor to that of full professorship until 1915, when I severed by connection with the Pennsylvania State College. During that time I had a leave of absence during the years 1906 and 1907, which I spent in study at the University of Goettengen, Germany. In 1914 I became connected with the Mellon Institute of Industrial Research at Pittsburgh, remaining in that connection until 1917. Since that time I have held various positions with the industrial works, first with the British-American Chemical Company, whose fellowship I conducted at the Mellon Institute, then as head of the National Tanners' Association, their experimental laboratory during the war. I was director of that. They called that the American Leather Research Laboratory. From 1917 to 1919 I was there, and in 1919 I went back for two years as technical director of the British-American Chemical Company. Since that time I have done some general consulting work, but the great majority of my time has been taken up by Irving L. Kieth as a sort of technical adviser. Mr. Kieth is a man of a number of activities, and

most of my time has been taken up with problems concerned with mechanical refrigeration. That is my position at the present time. I ceased work as a professor in 1914 and 1915. They overlapped. I was doing work for the Mellon Institute and for State College at the same time. I have not been a teacher or instructor since 1915. While I was at [fol. 87] State College I taught refrigeration incidentally in a course in industrial chemistry, and taught the general principles of refrigeration. I should say probably six or eight lectures each year were devoted to that topic. In the course of industrial chemistry we took up the subject in a general way, taking up and describing the different types of apparatus that might be used for the purposes of industrial refrigeration; also while I was at State College, prior to 1915, and covering, we will say, 12 years out of the 15, I gave lectures in elementary chemistry to the Freshman Class. In those lectures we showed the properties of solid carbon dioxide and illustrated the properties.

Q. And in your classes of refrigeration was the question of the use of solid carbon dioxide for the purpose of refrigeration raised?

A. No.

Q. As I understand it, in the industrial refrigeration program the use of solid carbon dioxide for that purpose was not discussed?

A. I do not believe it ever was. In our chemistry class we showed the production of solid carbon dioxide and described its properties by a series of experiments with solid carbon dioxide. That same course of instruction occurred each year for each Freshman class. There was very little change in the lectures or the material that was offered in those lectures from 1900 to 1915.

Q. In brief, what was the course of instruction in so far as the production or use of solid carbon dioxide was concerned, the physical properties of it?

A. We included that in one or two lectures on the prop- [fol. 88] erties of the oxides of carbon, the preparation of solid carbon dioxide was shown by mounting a large cylinder of liquid carbon dioxide, such as would ordinarily be bought in the open market; I think we purchased it from the Liquid Carbon Dioxide Company, or at times got it

from the local drug store, that was mounted with a clamp with trunnions on an iron stand, so we could show when the cylinder was in upright position nothing but gas escaped, and when it was inverted the liquid came to the bottom of the tank, and that liquid expanded in a canvas bag which was tied over the mouth of the cylinder; when the valve was turned on the liquid would flow into the canvas bag and expand therein, filling the bag with solid carbon dioxide snow. We then conducted experiments with that which showed its properties as a refrigerant, mixed it with ether, showed how mercury could be frozen, showed the temperatures obtained with the solids alone, and with the solid carbon dioxide mixed with ether, froze mercury, and froze eggs, and froze water in red hot crucibles by means of ether carbon dioxide mixture, and followed the usual experiments, which, however, were stereotyped, which has been probably given in almost every large university in this country and Europe for a great many years. As as part of the course the students were required to keep notebooks.

Q. Were you able to obtain the notebooks of any of the students who took this course under you?

A. You have two of those books there.

Q. What was done by yourself as an instructor with respect to the notebooks to keep yourself advised as to [fol. 89] whether or not the entries were being properly kept?

A. At certain periods we inspected those books, stamped them with a rubber stamp, and dated them; either Dr. Pond or myself or some other instructor went over them, and approved or disapproved them. If we disapproved them they had to rewrite the notes.

Q. The probability is these two were approved?

A. I believe so. I think they were both approved by Dr. Pond. His initial is P.

Q. Do you remember the students V. W. Smith and A. M. Slitze?

A. Yes, sir.

Q. They were students you instructed?

A. They were students who first took up chemistry in Dr. Pond's division. Later I instructed both of them.

Mr. Darby: I offer them in evidence.

Mr. Kerr: I object. It is apparent Dr. Churchill did not instruct these students, and in the second place, that he did not approve of the notebooks, because one of the other professors did.

The Court: If he did not approve them how can you get them in? He did not check them, he did not approve them.

Mr. Kerr: He did not actually give the course these students took in that Freshman year.

Mr. Darby: This note book of Slitze, with the initials of G. G. C., who is that?

The Witness: Grover G. Chandler.

Q. That is not yourself?
A. No.

[fol. 90] By the Court:

Q. Who gave the lectures?

A. I gave part of the lectures and Dr. Pond gave part of them. We had two large divisions. The lectures given were practically the same, whether Dr. Pond gave them or myself.

Q. Have you examined these notebooks to ascertain whether or not, in so far as they refer to solid carbon dioxide instruction——

A. They show the instructions we gave that time.

Q. That you yourself gave?

A. Yes, sir.

The Court: If he knows whether he gave them to these men?

By Mr. Darby:

Q. Did you instruct these particular students?

Mr. Kerr: In Freshman year.

A. I cannot say that I gave lectures to those particular students in the Freshman year, or that I did not. Both Dr. Pond and myself gave these lectures. These notebooks were approved by us working together. For instance, we took a pile of 360-notebooks on a table like that, I would correct some, he would correct the others. If my initials were in one it would be no proof I gave the lectures.

Mr. Darby: Do you still adhere to your objection, Mr. Kerr?

Mr Kerr: Yes, I do, your Honor.

[fol. 91] The Court: I sustain the objection. If they had his initials I might take them, whether he gave the lectures or not, because it might be the same lecture he was giving.

Mr. Darby: If it was the same lecture he had given, the witness's last answer would be a——

The Court: All right, but I do not think they are proven.

Mr. Kerr: Of course, we do not contest at all the fact that solid carbon dioxide was known, and as I stated in my opening that it was a customary thing in chemical courses to explain its properties, but I do not know what is in these books.

Mr. Darby: If you concede that, then we don't need the books. The testimony of the witness will stand.

Q. What personal experience did you have with the use of sol-d carbon dioxide as a refrigerant particularly?

A. I had, of course, used the solid carbon dioxide in the lecture course, was familiar with it, used to prepare it, and prepared it beforehand, wrapped it up in a blanket to keep it until the time we would need an extra large quantity to show. My first use, which was entirely personal, I believe, was made with CO_2, or solid carbon dioxide, in Goettengen, Germany, when I used solid carbon dioxide as a refrigerant, as a means of producing a low temperature in vessels in which I was carying on certain organic reactions [fol. 92] and again to produce low temperatures in liquids which crystallized with great difficulty, and sometimes I was able to accelerate the crystalli-ation or acceleration of those liquids whose freezing points were far below 32. That was in 1906 to 1907. I used the carbon dioxide several times, merely put the solid snow into a porcelain dish, surrounded flasks or small beakers, and again I used it in connection with ether, making a mush of the solid carbon dioxide and ether, and immersing the vessel in that. I used a number of times that same method in the classes on my return. I used exactly the same method in small dishes and in a great variety of ways. I used it on rather a larger scale for keeping liquids and reaction mixtures cool, especially for preserving—my initial use was for preserv-

ing ether nitrite. I might, in explanation say, in Pennsylvania State College during the summer it was difficult to get ice at the laboratory. We always had a large supply of liquid CO_2 in our store room, and it was easy to ask our janitor to run out a number of pounds of solid CO_2 snow in these canvas bags. I constructed a box, the outside box was a plain wooden box, and the inside box, about 12 inches wide and 12 high and 16 or 18 inches in length. A space between the boxes, say about 2½ to 3, that was lined with paper and lined with cotton, and for a cover I used a slab of Subrite cut to fit the box. I have made a drawing of this. The drawing 1-A represents the use that I made of solid CO_2 in the Goettengen Laboratory, where I merely cooled small flasks and beakers for a matter of perhaps a half an [fol. 93] hour or one hour, while the reaction was going on, and after the reaction was over.

1-B shows the same use, but where I continued the cooling of such vessels and enveloped the whole thing in a felt blanket.

Drawing 2 shows the use which I described of solid CO_2 with ether and snow—CO_2 snow and ether, but wrapped the contained vessel in a blanket to prevent the heat inflow.

Drawing 3 represent the use which I made of solid CO_2; the drawing is not especially detailed, but I think it shows clearly the maner in which I used this box which I have just described and used the CO_2 with various containers in the box without any solvent.

Drawing 4 represents the use of a solid CO_2 as a cooling medium. I took the canvas bags as they came off the cylinder and used them as a refrigerant, wrapping them in towels and placing them in the box.

And drawing 5 is one I should not be particularly proud about. Both Dr. Pond and I found we could make excellent use of it for cooling German beer during the summer months.

All of this was prior to 1915. I have not used solid CO_2 as a refrigerant since.

Q. Where did you put these ice boxes, if I can call them that, where were they located, in your laboratory?

A. Yes, in my private laboratory.

Q. Was it sealed against the students or professors?

A. Why, no.

Q. Was it in plain sight, not covered up so nobody could see?

A. It was not covered up so no one could see it, nor did I [fol. 94] ever take any special means of showing it to the general student public. I did not regard it at that time as anything novel. I wanted cold, and that was an easy way to get it.

Q. It was part of your regular duties?

A. I never thought anything about it other than if I brought a tank of ice up the roadway and wrapped it up in a blanket to keep something cold over night.

Mr. Darby: I offer the drawings produced by the witness as illustrating the use of apparatus he has described.

Mr. Kerr: I object on the ground they are drawing made now, and not made at the time; they are not contemporaneous.

The Court: That goes to the weight of them.

Mr. Kerr: And also obviously relating to an abandoned use.

The Court: That may be, but he can offer them now as his testimony in diagrammatic form.

(Marked Defendant's Exhibit D-1 to D-6 inclusive.)

By the Court:

Q. When did you make the drawings?

A. Made this fall.

Mr. Darby: This fall, for the preparation of this case.

By Mr. Darby:

Q. You were asked to obtain photostat copies of the scientific literature pertaining to solid CO_2 or solid carbon [fol. 95] dioxide. Will you please refer to those publications that you obtained, and give us the full date of publication and the name of the publication, the page, and read the short statements pertaining to solid carbon dioxide that you located.

A. I have one or two foreign publications here that I will refer to first, and merely give you the essentials of them.

Mr. Kerr: I again object, your Honor. If these are in any way offered as anticipatory, because we have had no notice of them.

Mr. Darby: As we view the case, the case is for a box, and this is merely showing the state of the art which we contend we follow rather than the patent in suit.

The Court: All right, go ahead.

A. The first is a photostat copy of pages 432, 433 and 434, from the Annalende Chemie and Physic, dated 1835. This is the original paper written by Thilorier and describing the preparation of solid carbon dioxide.

The second is from the same journal, Annalende du Chemie, under date of 1839, at pages 122 to 127 inclusive, and a drawing, photostat drawing, that belongs to the same article showing the apparatus.

By the Court:

Q. What are they written in, French?

A. These two are in German.

A. (Continuing:) The next is a photograph of page 752, [fol. 96] taken from Wurtz Dictionary du Chemie, Volume 1, Part 2, 1876. This again describes a preparation of solid CO_2.

There is another photostat taken from Comptes Rendu, 1884, page 99, describing the preparation of solid CO_2, and speaking especially of its use by physicians in producing cold for preserving specimens, and so forth, as a forerunner of its industrial use.

This one is a photostat from the Berichte, 1884, Volume 17, pages 309 to 311, preparation of solid CO_2 is described in detail, and also a statement of the fact that liquid CO_2 could be bought at that date in Germany in the market.

I come now to the English abstracts, and these I can read from if you will bear with me. The first one is from Thomson's Dictionary of Chemistry, New Edition, the date of its publication between 1845 and 1850. The portion bearing on solid carbonic acid is this:

"Thilorier has succeeded (Ann. Chim. 60, 427) by imitating in the first instance the experiment of Faraday—using iron cylinder instead of glass—in condensing carbonic acid into a liquid, and then by an ingenious method

of causing it to revolve when emitted by the stop-cock round a hollow hemisphere, it vapourizes and produces so much cold as to cause it to condense into a solid form like snow.

"A more safe and convenient method is to prepare the fluid acid by means of a pump."

The next abstract is from Graham, "Elements of Chemistry," Second Edition, Volume 1, 1850. This describes [fol. 97] the apparatus known at that date as the Natterer apparatus. The portion bearing on the subject is this:

"Solid carbonic acid is a very bad conductor of heat, and may, therefore, be handled without injury, although its temperature is supposed to be so low as -100° C., or -148° Fahr.; and also preserved in the air for hours, if a considerable mass of it in a glass vessel be placed within another similar and larger glass vessel, with any non-conducting material between them. When applied to produce cold, in order to give it contact the solid carbonic acid is mixed with a little ether, with which it unites and forms a soft semi-fluid mass like half melted snow, capable of abstracting heat and evaporating rapidly, by means of which mercury can be frozen in large quantities, and an alcohol thermometer sunk in the open air so low as -135° (Thilorier). The apparatus of Thilorier forms thus an invaluable cold-producing machine."

Q. Now before you take up the next one, what is the significance of the statement "Solid carbonic acid is a very bad conductor of heat, and may, therefore, be handled without injury, although its temperature is supposed to be so low as -100° C., or -148° Fahr."?

A. He is describing the fact that solid carbon dioxide gives off a gas, and there is a gas layer which is a highly insulating layer between the solid form of carbon dioxide and any substance pressed against it.

[fol. 98] Q. And that is the reason why one can place his hand on the solid carbon dioxide without freezing his hand against it?

A. It is, yes.

The next one is an abstract from Odling: "Outlines of Chemistry," 1870. Again in this article Natterer's appa-

ratus is described in the properties of solid carbon dioxide. This article refers to solid carbon-hydride. That is also a name for carbon dioxide. And there appears:

"Its capability, nevertheless, of being handled, &c., owing to an absence of contact, by reason of its volatilization."

That is another way of expressing the same thing I expressed a moment ago.

Q. It also reads: "Its comparative permanence when surrounded by non-conducting materials." Is that equivalent to the statement appearing in one of the previous articles——

A. It is a statement you can preserve it by insulation.

Q. It has relatively long life if insulated?

A. It volatilizes only as the heat gets to it and causes it to volatilize.

The next is from Spons' Encyclopedia of the Industrial Arts, Manufactures and Commercial Products, Volume 1, 1879, page 47. That pertaining to the question is as follows:

"When the liquid carbon anhydride is suddenly freed from pressure, it is instantaneously converted into the gaseous form, and by the operation such intense cold is produced, that a portion of the liquid is frozen. It then forms [fol. 99] the solid anhydride, a white, snow-like mass. Though this substance has so low a temperature as -78°, it can be handled without inconvenience, owing to a constant volatilization, which keeps it from actual contact with the hand. Wetted with ether, solid carbonic anhydride forms the most effectual freezing mixture known, a temperature of -110° being obtainable, and mercury instantly solidified into a lead-like mass. If when liquefying the gas at a temperature of -87° the pressure is increased to four atmospheres, a solid mass is obtained, which has the transparency of ice, and may be divided into crystals, which have the action of intense heat when pressed between the fingers."

The next abstract is from Newth, "Chemical Lecture Experiments," 1892, pages 182, 183 and 184. The only parts which I wish to read are:

"The solid when collected should be removed from the metal receiver and placed in a car-board box, which may be thickly covered with felt."

The next abstract is from Roscoe & Schorlemmer, "Treatise on Chemistry," Third Edition, Volume 1, dated 1898, pages 720, 721 and 722

"When the stopcock of a vessel containing liquid carbon dioxide is opened, a portion of the liquid which rushes out solidifies in the form of white snow-like flakes (Thilorier). [fol. 100] This is caused by the absorption of heat, produced by the rapid evaporation of another portion of the liquid. For the purpose of obtaining larger quantities of this carbon dioxide snow, the apparatus shown in Figs. 195 and 196, suggested by Natterer, is employed."

Then it goes on with a brief description of that apparatus, which is not pertinent, and then it says:

"This snow-like mass may readily be pressed into cylindrical wooden moulds. The cylinders thus obtained have a density of about 1.2 and require a considerable time for evaporation in the air. When solid carbon dioxide is mixed with ether, and the mixture brought,"

and so on, a great degree of coldness is produced.

"A process has been patented for carrying out the manufacture of solid carbonic acid by a similar method on the large scale. The solid material may be transported in bags or casks, or in the iron chamber in which it is produced."

The next photostat I wish to put in evidence is the Journal of the Society of Chemical Industry, 1904, Volume 23. The only portion I wish to read is this. It describes the general method of making solid CO_2, and I wish to emphasize just this paragraph:

[fol. 101] "A force-pump, o, n, serves to remove the solid dioxide, which may be conveyed into the steel cylinder shown in Fig. 2, fitted with double envelope, &c. like that represented in Fig. 1. Such cylinders are provided with means for charging and discharging similar to those in

ordinary use for storing and conveying liquid carbon dioxide."

This is from the Journal of the Society of Chemical Industry, November 30, 1892, Volume 11, page 936:

"Carbonic acid from brewers' vats (this Journal, 1891, 651), or from any suitable source, is liquefied in a series of stage compressors, the liquid cooled down in a surface condenser and admitted in regulated quantities into an expansion chamber. Part of the liquid volatilizes here, and in consequence abstracts sufficient heat to cause the remaining part of the liquefied carbonic acid to solidify. The gaseous carbonic acid may be returned to the pumps. The solidifying chamber may be made fixed or movable; it is provided with a discharging door for the solid carbonic acid, and it is coated with non-conducting material. Boxes, bags, or the solidifying chamber itself may be used for transporting the solid carbonic acid."

The next one is from Roscoe & Schorlemmer, "Treatise on Chemistry," Fifth Edition, Volume 1, 1920, page 812. [fol. 102] This I will not take the time to read. It merely gives a general description of Natterer's apparatus and the preparation of solid carbon dioxide.

Q. I call your attention to the fact that the statement "The solid material may be transported in bags or casks, or in the iron chamber in which it is produced," appears in the preceding article.

A. Yes, sir. That is on page 814.

The next is Sir Edward Thorpe's "Dictionary of Applied Chemistry," Volume 2, 1921, page 69:

"Liquid carbon dioxide can be obtained in large quantities by an apparatus described by Thilorier (Annalen, 30, 122). Natterer compressed carbon dioxide by a specially constructed air-pump (J. pr. Chem. 35, 169; also Gore, Phil. Trans. 1861, 63). It is prepared from bisulphates by the action of carbonates, the apparatus consisting essentially of a leaden vessel containing a solution of the bisulphate and having a stirring apparatus and gear fixed airtight to it. By means of a tube and pump an equivalent

quantity of calcium carbonate (obtained as a waste product in the manufacture of caustic soda) suspended in water in a second vessel is forced in and the stirrer set in motion. The liberated carbon dioxide is dried and passed into a gasometer from which it is afterwards condensed."

"Liquid carbon dioxide may be bought in iron or steel [fol. 103] bottles containing 8 kilos, (about 4,000 litres of the gas at ordinary temperatures and pressure), costing about 1 sh. per kilo. It furnishes the cheapest means for aerating waters, and is used for raising sunken ships, for driving torpedoes, for extinguishing fires, for cooling purposes, and, as 'Pictet's fluid,' for freezing machines, and by the firm of Krupp, in Essen, for the condensation of steel and other metals, and is further suggested as a motive power for tramcars and balloons."

"Liquid carbon dioxide is colourless, very soluble in alcohol, ether, and volatile oils, but does not mix with water. When the pressure is suddenly relieved, part of the carbon dioxide immediately vaporizes, producing sufficient cold to solidify the remainder. Landolt allows the liquid to evaporate freely into woolen bags, and compressed the solid carbon dioxide in conical wooden moulds by wooden pistons (Ber. 17, 309); cf. Purcell (J. Soc. Chem. Ind. 1892, 936; Eng. Pat. 13684, 1891). A vessel for storing solid carbon dioxide is described by Heyl and Wultze (J. Soc. Chem. Ind. 1904, 1215; French Pat. 344,957, 1904).

"An apparatus for obtaining small and large quantities of solid carbon dioxide is described by Fechlu (J. pr. Chem. 1903, 67) 423; (J. Soc. Chem. Ind. 1903, 626); also by Elsworth (J. Soc. Chem. Ind. 1905, 1231). (For an apparatus [fol. 104] for collecting solid carbon dioxide, v. Ducretet, Compt. rend. 99, 235.)

"Solid carbon dioxide is a white, flocculent, snow-like mass, melting at -56.7° at 5 atmospheres pressure, and may be left exposed to the air for some time without sensible evaporation."

The next one is Pellew, "Laboratory Text Book of General Chemistry," 1901, page 69:

"It can readily be obtained in a solid form, like snow, by allowing some of the liquid carbon dioxide to escape from

the exit valve of a cylinder into a cloth bag, the cold, produced by the sudden expansion of part of the liquid, condensing the rest into a solid form. Solid carbon dioxide melts at -65°, a point above its normal boiling point. If mixed with ether and allowed to evaporate under an air pump, the temperature will be reduced to -110°."

(Adjourned until Monday, February 27, 1928, at 10:30 A. M.)

Brooklyn, N. Y., February 27, 1928.

Met pursuant to adjournment at 10:30 A. M., present as before.

Mr. Kerr: If your Honor please, there are two points I find I neglected to put in in my prima facie case; the first one was when the sales began from the Carbice Company to Marchiony.

[fol. 105] Mr. Darby: I will stipulate that the sales made by the Carbice Company, the defendant, to Marchiony, were prior to the commencement of this action and subsequent to the issuance of the patent.

Mr. Kerr: And the second point was I wanted to show that the manufacturer of this solid carbon dioxide for the Carbice Company was the General Carbonic Company.

Mr. Darby: I object. That is wholly irrelevant and immaterial.

Mr. Kerr: It is one of the stones that make up our case.

The Court: What difference does it make? You are not suing them?

Mr. Kerr: These were the people that manufactured for the plaintiff.

The Court: If you want to sue them, that is one thing, but what difference does it make where these people get it?

Mr. Kerr: To show they tailed in all the time, following our people.

Mr. Darby: I object to it as wholly irrelevant and immaterial, but if Mr. Kerr wants it in for some reason, I will stipulate it.

The Court: I cannot see what it amounts to, but he may develop something on it.

Mr. Kerr: The fact that the solid carbon dioxide——

The Court: You are going to get yourself down to the fact, if you keep on, that these people bought a commercial article and sold it to somebody.

[fol. 106] Mr. Kerr: That they bought the solid carbon dioxide from the General Carbonic Company.

The Court: Is it a commercial article that the General Carbonic Company was selling to anybody?

Mr. Kerr: No, it was not a commercial product.

The Court: Go ahead, get it in if you want it.

Mr. Darby: I am willing to stipulate that the defendant Carbice Company bought a commercial article, solid carbon dioxide, from the General Carbonic Company. If you do not care to accept that stipulation, you had better prove it.

Mr. Kerr: I would like to be able to put a witness on the stand and ask him one question.

The Court: Then if you do not prove it you are out. He offered you something.

Mr. Kerr: I am not willing to accept that "commercial article".

The Court: All right, then you will have to prove it.

Mr. Kerr: If I may subsequently call a witness to that effect.

The Court: Yes.

Mr. Darby: As soon as we complete the direct and cross-examination of Dr. Churchill you can reopen your prima facie case, I understand?

The Court: Yes.

[fol. 107] Jesse B. Churchill recalled.

Direct examination continued.

By Mr. Darby:

I will continue my consideration of these scientific publications.

I have translated two foreign publications.

I cite from an article on Carbon in Wurtz, Dictionnaire de chimie, Volume 1, part 2, 1876, page 752. Paragraph 2:

"Solid carbon dioxide can be kept for a much longer period than the liquid as the evaporation is very gradual

which is caused by the poor conductability of the material; a flake placed on the hand does not give a sensation of intense cold because the solid carbon dioxide isolates itself from contact with the hand by means of the enveloping gas vapor, if, however, one presses solid carbon dioxide against the skin there is a sensation of intense pain and the skin becomes burned as with a hot iron."

The second and last is taken from Landolt's article in Berichte, 1884, Volume 17, pages 309 to 311. Page 309, paragraph 1:

"Since the 'Corporation for the carbonic acid industries', of Berlin placed liquid carbonic acid on the market in iron cylinders of 8 kilograms capacity it has been easy to prepare solid carbonic acid in any quantity desired."

[fol. 108] Then page 310, paragraph 1, describes the carbon dioxide snow:

"Of the form of interlocking white flakes carbonic acid snow possesses the property of being sufficiently permanent in the air so that many experiments such as the freezing of mercury can be performed. But a heap of such snow of about a cubic decimeter will disappear in a half an hour. If, however, one presses this snow together for example, in a cylindrical form, one obtains it in the form of hard pieces in which there is no gasification internally but only on the outer surface. And in this condition the material is much more stable."

In my notes "stable" is the best translation I can give. It does not evaporate or disappear as fast.

And paragraph 2 reads:

"For the preparation of such pieces of solid carbonic acid I have used strong walled wooden forms with a cylindrical bore of forty-one and twenty-five mm. diameter with the necessary corresponding stamps. Snow-like carbonic acid is fed into the mold portionwise and the stamp (piston) forcibly driven down by blows of a hammer. In this way strongly compressed masses are obtained."

Q. Will you please translate that into the English system, what would be the size of the solid carbon dioxide cake that you would secure?

[fol. 109] A. The diameter of the first one would be approximately 2 inches, and of the second cylinder about one inch in diameter. Later in the paper it gives the length. Paragraph 3 reads:

"In this manner cylinders of the compressed carbonic acid can be obtained. These have a chalk-like structure and are difficult to cut with a knife but may be broken in pieces. Exposed to moist air these cylinders surround themselves with a mist of frozen water, possibly the hydrate of carbonic acid."

That is what we know in chemistry as true carbonic acid. Paragraph 1 on page 311 reads:

"The evaporation of the compressed carbonic is observed to be much slower."

Then I left out a portion that is immaterial, and continuing in the same paragraph:

"such a cylinder will remain in the air several hours before complete evaporation takes place. For example, a cylinder of compressed carbonic acid forty-one mm. in diameter and sixty-three mm. high corresponding to a volume of 70.9 com. took five hours to completely disappear while a cylinder twenty-five mm. in diameter and twenty-six and eight-tenths mm. high which weighed fifteen and six-tenths grams disappeared in one hour and forty minutes. [fol. 110] These cylinders can be preserved against evaporation by wrapping them with thin rubber cloth then with blotting paper and wrapping paper."

Q. Take either of the sizes of solid carbon dioxide blocks described in that paper. How do they compare with the sizes of the solid carbon dioxide blocks that was presented here in court?

A. It would be very much smaller. The larger block described there is approximately a little under 2 inches, between 1½ to 2 inches in diameter, and 2½ to 3 inches high.

Q. 25 millimeters in diameter?

A. The smaller block is. The larger block is 41 millimeters in diameter.

Q. And 63 millimeters high?

A. There are about 25 millimeters to an inch, if I recollect rightly.

Q. How do the physical characteristics of the block of solid carbon dioxide described in this paper of 1884 compare with the characteristics of the piece of solid carbon dioxide which was here in court the other day, another piece of which is here?

A. I should say they were in general perfectly similar, but that every block of compressed carbonic acid snow will vary slightly, according to the pressure that is put on it in compression. This may be a little denser or not so dense, but otherwise they are in general about the same.

Mr. Darby: I offer in evidence the 16 technical extracts referred to by the witness and quoted from.

[fol. 111] Mr. Kerr: I object to them as immaterial.

The Court. Received. Objection overruled.

(Marked Defendant's Exhibits E-1 to E-16 inclusive.)

Mr. Darby: You may cross-examine, Mr. Kerr.

Cross-examination.

By Mr. Kerr:

I have stated that I was a Fellow at the Mellon Institute of Industrial Research. The Mellon Institute of Industrial Research is an institution in Pittsburgh which was founded for the purpose of establishing fellowships for carrying on commercial investigations. The fellows are chosen by the Director of the Institute and the Assistant Director, as I understand. It is rather an honor to be chosen for a Fellowship. I attended a meeting of the American Institute of Refrigerating Engineers last December, and heard Mr. James W. Martin, Jr., read a paper on Solid Carbon Dioxide.

Q. You joined in the discussion following the reading of that paper, did you not?

A. I believe not. I may have. Frankly, I don't remember.

Q. I hand you herewith the February, 1928, number of "Refrigerating Engineering," which has an article entitled

"The Field of Dry Ice in Modern Refrigeration, by J. W. Martin, Jr.," beginning on page 33, and on page 55 appears the following:

"Mr. J. B. Churchill told of an experiment of his in which [fol. 112] he sent three quarts of ice cream packed in a paper package with dry ice to Portland, Oregon. The package weighed 60 pounds and lost 22 pounds in weight. The data were not absolutely accurate, but it was shown that a much greater amount of refrigeration would have been required than was shown by the melting of the 22 pounds of dry ice on the trip. The ice cream arrived like blocks of cement; it took about 10 hours to thaw it out so that it could be eaten."

A. That is correct.

Q. That was practically what you said at the meeting?

A. Yes, sir. I had forgotten that came up.

Q. As stated in such discussion, you did ship three quarts of ice cream to Portland, Oregon, in a paper package refrigerated with solid carbon dioxide, with the results as stated, did you not?

A. I did, and that was done by Mr. Martin and myself. The ice cream was shipped to a niece of mine in Oregon sometime—I have forgotten the exact date.

Q. Did you at any time prior to 1924, by publication, or in any of your lectures, show that you then recognized that solid carbon dioxide was far more effective than water ice on the B. t. u. basis?

A. No. In fact, I do not think in any of the lectures given to Freshman in Pennsylvania State College that the question of B. t. u. has ever come up in any way, or latent heat of solid CO_2. In regard to the shipment, that was made by Mr. Martin and myself. Mr. Martin very kindly [fol. 113] got the package ready, and the package of ice cream was sent to Hood River, Oregon, to a niece of mine, just as a novelty. I had no special interest in the experiment except that Mr. Martin had been telling me about shipments made, and that flashed into my mind, that it might be an interesting thing to do.

Q. How did you explain the remarkable efficiency which was shown in the refrigeration of this package which you shipped?

The Witness: I do not think I ever made any explanation of it.

Mr. Darby: In the first place, the questions assumes remarkable efficiency, which the witness has not testified to, and it does not appear in the article.

The Court: He asked him if he ever did do it.

Mr. Darby: He shipped it, he said.

The Witness: The Dry Ice Corporation shipped it.

Q. You participated in the shipment, did you not?

A. Yes; it was a purely friendly stunt between Mr. Martin and myself. It had no scientific or commercial significance in any way.

Q. How long was the shipment enroute?

A. Six or seven days. I have not any exact data about it here, but it is my impression it was about a week getting out there.

Q. Do you know how much solid carbon dioxide there was in the package?

A. No, I do not think we—Mr. Martin can tell you how much he put in. The package, I believe, weighed 52 pounds and lost 22 pounds in the shipment.

[fol. 114] Q. The article says 60 pounds and lost 22 in weight?

A. Yes, lost 22 in weight.

Q. That agrees with your recollection, doesn't it?

A. Yes; there was 22 pounds of solid carbon dioxide used up, if their scales were right there. All I have is a letter from a young girl not scientific in any way, and the scales were probably household scales, but the probabilities are it is roughly correct, within a pound.

Q. You have referred to some experiments with solid carbon dioxide in refrigerating various liquids in Germany and in your laboratory at State College?

A. Yes, sir.

Q. Since 1915 have you ever used solid carbon dioxide in such a way as you have described in these experiments?

A. I do not recall, Mr. Kerr, of using it since that time. I believe that at Ridgefield Park during some work we did out there, that I recommended to our head chemist to use solid carbon dioxide as a cooling agent for certain chemical

experiments, but I would not say he did. I showed him how to make a cylinder of carbon dioxide out there, but I do not think I have ever used it since 1915.

Q. In these experiments in Germany and at State College at the time did you think you had done anything remarkable?

A. Absolutely not. I never thought of ascertaining what the B. t. u. value of solid carbon dioxide was. All I wanted to do was to get a low temperature. There was no question of expense involved. I was not interested in that side of it in the least.

Q. You have said in reference to the Graham publication, which is one of the publications you referred to in your [fol 115] direct examination that "There is a layer of gas which is a highly insulating air layer between the solid form of carbon dioxide and any substance pressed against it." How long can you hold your hands pressed against the piece of solid carbon dioxide before you here without pain?

A. Well, that would depend upon a great many things, the toughness of your hide, and the pressure you put on your hand. If you actually crushed that up in your fingers good and hard——

The Court: Whether you are suffering from high blood pressure or low blood pressure——

A. Possibly, but it would be a very, very short time.

Q. That is, this supposedly protective film of gas actually does not prevent your suffering considerable discomfort if you hold it for a very few seconds?

A. Unless the snow is very light. You can take carbon dioxide snow and press it up into snow-balls, if you are a little cautious—if you do not get it where you pinch it between your fingers.

Q. In the same way, you can pick a red hot coal up for a second?

A. No, you can handle it much easier than that, because there is considerable protection. You can handle a lighter piece much easier than you can a large heavy one. For instance, if you take a piece one-quarter that size you can juggle it around in your hand a good many seconds without

dropping it. I have never been interested enough to try that for any length of time.

[fol. 116] Q. How is the refrigerating value of a substance measured?

A. I have never made any measurements of the refrigerating value of solid carbon dioxide. It would be measured in some apparatus which was appropriate to show how much heat was necessary to evaporate under correct conditions of an accurate physical experiment. I have never attempted to ascertain that value of solid carbon dioxide. We can take the published values as correct for commercial purposes and there probably will be data in the next few years that will be highly correct.

Q. In your course at State College on Industrial Refrigeration you dealt, among other things, with the use of carbon dioxide in alternate gas and liquid form in a close compression and expansion system, did you not?

A. In a very general way. This was not a course on refrigeration, and there were several lectures devoted to refrigeration and the different types of refrigerating machines. The general properties of a compression machine were explained, and the types commencing with the air machines and the ordinary compression machines were mentioned, but no detail was gone into. For instance, if I could answer the question this way, the course only extended to such an extent that a student would know what a refrigeration machine was, and what purposes it would be applied to in industrial chemistry.

Q. And those systems were closed systems, the liquid, or gas, that was contained in them, did not get out into contact with the thing that was being refrigerated that is correct?

A. That would be correct for a closed system.

[fol. 117] Q. The systems you were dealing with were of that sort?

A. I can answer that question more directly if you wish to know whether or not in those lectures I touched on the use of solid carbon dioxide. I will say I did not in any way.

Q. But these mechanical automatic closed systems, what was it that they cooled?

A. We did not speak of them cooling anything, just the general principles of a refrigeration machine.

Q. As a matter of fact, they cool air, do they not, normally?

A. You cool air or brine, or it might be a cold storage proposition. It might cool a tank of chemicals, almost anything.

Q. And in such a system which used carbon dioxide, what would happen if solid formed in it?

A. I frankly would say that solid carbon dioxide would not form in such a system. That would be my impression. I am not an expert on carbonic acid refrigerating machinery.

Q. An endeavor would be to keep it from freezing?

A. In any ordinary machine we do not have the formation of solid carbon dioxide within the machine. Whether or not there can be a state of operation which would allow solid carbon dioxide to form, because of some imperfection of the operating practice, I would be unwilling to state. I do not know whether that has ever happened or not.

(Witness excused.)

[fol. 118] JOHN E. STARR resumed.

Direct examination continued.

By Mr. Darby:

Q. I believe you were to produce your original memorandum concerning the two instances of your actual use of the solid carbon dioxide as a refrigerant. Will you produce the memoranda one at a time, stating what test they refer to, and explain the notes and all that you can tell us about the respective memoranda?

A. This memorandum refers to the comparative cost test that I referred to in my testimony in regard to the test made in St. Louis of solid CO_2 against ammonia with the fountain and absorber system. As I explained, this same box of the fountain and absorber or ammonia system was used to refrigerate, obtaining the atmosphere of about 20 below zero, and in the same box CO_2 was used for the same

purpose, obtaining the temperature of about 40 below in the refrigerator. In this same length of time this memorandum shows that—if I may explain—in both cases the exact amount of CO_2 snow and ammonia that was used during the test was ascertained by weighing. The object of the operation was to freeze tissue very hard and to maintain it frozen for a certain length of time. This memorandum reads that it took 1.6 pounds of ammonia, which is equivalent to taking up as much heating as 5.8 pounds of ice, and in the same time it froze the tissues to temperatures of -40, and used in the same time 2.32—practically [fol. 119] 2⅓ pounds—of CO_2. The cost of the use of the ammonia was about equivalent to half a cent a pound, and it was estimated at that time that CO_2 would cost a great deal more. I do not remember exactly the figures, but it was six or seven times as much.

Q. Where has that paper been from the date of those tests?

A. That paper was originally in my papers in St. Louis, and were forwarded here about a year ago in a trunk, along with a lot of other papers, and within the last week or two I examined these papers and found this memorandum among them, which I recognized as a memorandum that was made at the time that these tests were made, although it is undated. I positively identify that sheet of paper. I can interpret the meaning of all these figures here, and remember how and under what circumstances I made them. The paper that I hold in my hand is in the identical condition it was when I took it out of the trunk. I have not torn anything from it.

Mr. Darby: I offer the paper in evidence.

All the entries on that piece of paper are in my handwriting. I cannot give a definite date as to when it was I made this test in St. Louis. It was certainly prior to the year 1900. It must have been.

Mr. Kerr: I object as incompetent and immaterial.

The Court: It is his own handwriting. He says he made it at the time.

[fol. 120] Mr. Kerr: There being no date on it to identify it.

The Court: All right, that only goes to the weight of it.

(Marked Defendant's Exhibit F in evidence.)

Q. Now, will you please produce the record you referred to in your previous testimony relating to the second test for Mr. Hugh Grant?

A. The second test which I have testified to was a test made in New York City to determine how much CO_2 ice it would take to hold a refrigerator at a certain temperature, that is, a temperature somewhere in the neighborhood of 45 to 50, as against holding the same temperature with a certain amount of water ice for the same period of time. As I testified, the CO_2 ice was placed in a bag in order to insulate it so that it would not take up heat so rapidly, and therefore produce too low a temperature in the refrigerator, as we could only get between 40 and 50 in this refrigerator with ice. This memorandum shows that in the preliminary test the ice was put in one bag, therefore only surrounded with a comparatively light insulation, and that the temperature produced in the refrigerator ran down below the freezing point, that is, as the memorandum reads, ran down to 41, 31 and finally 30. I distinctly remember that this temperature was not considered as a parallel to the ice test where the temperatures obtained were in the neighborhood of anywhere from 42 to 47. Therefore, this first bag was placed in another bag so that there were two thicknesses of bag around the CO_2, and this so insulated it [fol. 121] that it received heat slower, and hence the temperature in the refrigerator was higher, and I see by this record that the temperatures obtained in the box were 52 at 9:30, 44 at 10, and so on. I went down to about 42 at 11 o'clock and maintained it at 42 until about one o'clock. This was very nearly the same average temperature that was obtained with ice in a box of exactly the same construction. I find that in order to maintain these temperatures the same, or in other words, to produce the same kind of refrigeration or remove the same amount of heat from the interior of the refrigerator to the outside area that it took 1.98 kilograms of CO_2 and 3.78 kilograms of ice, which was practically 4 pounds of CO_2 and 7.84 pounds of ice. These figures I find on this memorandum and remember exactly what they mean, and this memorandum is made in

my own handwriting, and was made in an office diary, which is dated 1903, but I am quite sure that this date of 1903 has no significance as fixing the date of this memorandum, because this book, instead of being used as a diary, was used as a memorandum book by me for some two or three years to jot down little memoranda that I wished to keep record of for a short length of time in contradistinction to more important memoranda which I wanted to put in my regular note book, and I find in here a large number of other memoranda of the same nature which I know from memory were inscribed in this book without reference to the date under which they appear.

[fol. 122] Q. Do you positively identify that memorandum as pertaining to that comparison you made for Mr. Hugh Grant?

A. It was made at the time Mr. Hugh Grant was living, and was prior to the death of Mr. Hugh Grant. His death was in about 1919.

Q. What I am particularly interested in is, do you positively identify that memorandum as the memorandum relating to that test?

A. I positively identify it as such, yes.

Mr. Darby: I offer the memorandum in evidence, just one page.

The Witness: That memorandum is in a book entitled "Dodge reports 1903," Friday, May 22nd.

Mr. Kerr: I object to it as incompetent and irrelevant.

The Court: Overruled.

(Marked Defendant's Exhibit G in evidence.)

Mr. Darby: You may examine, Mr. Kerr.

The Court: These were not pleaded as anticipations?

Mr. Darby: Oh, yes, sir.

The Court: They were pleaded?

Mr. Darby: Yes, sir.

Cross-examination.

By Mr. Kerr:

Q. With regard to this yellow sheet memorandum, Mr. Starr, marked Defendant's Exhibit F, is there anything

on there to indicate that this related to those St. Louis tests——

[fol. 123] A. No, sir, not on that memorandum. No, sir, I find no reference to St. Louis.

Q. Or to the fact they were for a doctor there, or anything of that sort?

A. They were not made directly for a doctor, but they were made in order to find and advise the doctor what was the best method of doing what he wished to do.

Q. Is there anything to indicate that there?

A. No, sir, not a thing. There is not a thing to indicate it is in connection with a particular experiment for a particular person at a particular time.

Q. With regard to the page which is marked Friday, May 22nd, in this 1903 Year Book, which is offered in evidence as Defendant's Exhibit G, there is nothing on this sheet to indicate these experiments were for Mr. Grant or in connection with Mr. Osborne, or anything of the sort, is there?

A. No, sir, nothing.

Q. In these two experiments you found that the refrigerating value of solid carbon dioxide was approximately two to one to that of water ice, did you not?

A. What do you mean by the refrigerating value—the amount of heat that it would take up?

Q. Yes.

A. Yes, sir. In a very rough way. I see by looking over this memorandum that one pound of CO_2 took up as much heat as it would take about two pounds of ice to take up roughly, very roughly. I think it might vary from that 20 per cent. or 30 per cent., one way or the other. It has been since accurately determined by myself.

[fol. 124] Q. Do you remember the exact ratio?

A. Yes, sir—well, the exact ratio would depend a great deal on the temperature which you sought to obtain, that is, the temperature you would allow the gas to rise. It would vary if you were using it in a refrigerator and only sought a temperature of 32 in that refrigerator, the CO_2 would only receive heat of course up to 32, and would not be used. If your refrigerator was say at 80, the CO_2 would be available up to 80, so that the exact figure determined was the amount of heat it would take up at its subliming point of 114 degrees below zero. At that point

it would take 246 B. t. u's to change a pound of solid to a pound of gas, then the gas would rise in temperature to whatever temperature you would allow it to rise, and it would take in that rise two-tenths—the specific heat of the gas is two-tenths—so it would be two-tenths of the number of degrees it was allowed to rise, so that the exact B. t. u's would be 246 plus two-tenths of the number of degrees it rose in temperature, which would roughly be anywhere from a pound and three-quarters to two pounds and one-tenth, probably, in practice.

Q. You have spoken of an ammonia refrigerating system, that is the closed type circuit type of system, is it not, in which the gas and liquid ammonia which is at various stages in the system never comes in contact with the thing refrigerating?

A. Yes, sir, it does not.

Q. You have spoken of using methyl chloride. Was it used in a closed mechanically operated system using the compression and expansion principles?

[fol. 125] A. I suppose all liquid chloride methyl, supposing the methyl was already liquefied, it would then take up heat by reason of expanding into gas, and that gas would spread out among the packages that you sought to refrigerate, the difference between that and CO_2 being the chloride of methyl would probably badly affect the packages being refrigerated, unless the packages were hermetically sealed against the gas. As far as taking up the heat is concerned, the heat transfer would be exactly the same in one case as in the other.

Q. Did you ever hear of anyone trying such a substance—

A. Why, nobody would, of course, knowing that fact.

Q. So it really has no bearing on the situation here, has it?

A. I do not know whether it has a bearing on the situation or not. It is a fact.

Q. It is not a practical commercial proposition?

A. No, it would not be used commercially.

Q. And the substance that you speak of would have been used as a liquid and not as a solid, isn't that correct?

A. It probably would, but that does not mean to say it could not be used as a solid. I have used ammonia as a solid.

Q. But it is not used commercially?

A. No, not used for that reason. It would probably combine with some of the articles that were sought to be refrigerated and would be objectionable from the human standpoint—it would smell bad.

Q. There are a number of various substances, liquids and gases, used in these closed mechanical systems, are there not?

[fol. 126] A. Mostly liquids that are boiled out in the closed system, used in the boiler.

Q. And they are converted into gas and then converted into liquid?

A. Boiled out, the same as water is in steam.

Q. And in none of them the refrigerant comes in contact with the thing refrigerated, isn't that correct?

A. I think there are none of them, that is in practical every-day use. Carbon dioxide is used in such a closed mechanical system, in liquid form.

Q. Does solid carbon dioxide form in such a system?

A. Not usually. There is a system in which they start off with liquid and solid carbon dioxide is formed, part of the liquid goes to solid carbon dioxide and part of it escapes as a gas, taking up heat, and in the process or in the cycle solid carbon dioxide is an incident.

Q. Is it a complete cycle you are speaking of?

A. A complete cycle, yes, sir.

Q. What is that system?

A. I think that was a system that was used in this town here; where, I have forgotten the name of the concern operating it, but I know, in fact, it was handled about this way: That a cylinder of liquid carbon dioxide was attached by a piping to a chamber in the top of the refrigerator, or somewhere in the refrigerator, and the liquid was allowed to pass through a small orifice into this chamber or space, as you might call it, and in doing so a part of the liquid would deposit as a solid and the balance of the liquid exit from the chamber as a gas, and then the solid carbon dioxide also would sublime and go out as a gas along with [fol. 127] the other gases. I do not think they recovered any of that gas. I saw that system in operation within a year or so.

Q. It was a very recent thing, wasn't it?

A. It is recent. I have seen that particular thing in operation, yes, sir.

Q. But in these commercial systems, these closed mechanical systems that I have referred to, it is never desirable to have solid carbon dioxide form, is it?

A. No, it is undesirable to have it, because it would not be sufficiently mobile to be handled successfully in that kind of an apparatus.

Q. In such systems would you say that anything that would cause an increase of efficiency of 10 per cent was a substantial increase?

A. That is a rather comprehensive question—10 per cent. In most operations 10 per cent is considered a substantial increase, yes.

Q. You have mentioned a number of different refrigerants, in which ones of these is the refrigerant in solid form and the gas from which, as the solid sublimes, surrounds the products to be refrigerated with an insulating envelope of gas?

A. None of them are in commercial usage, except in practical commercial usage any of them could be used.

Q. Did I understand you to say any of them could be used in practical commercial use?

A. Yes. Not in practical commercial use; perhaps they could be used if special provision were made for so using them.

Q. Is there any sublimation of water ice in the usual water ice box or refrigerator?

[fol. 128] A. No, there is no sublimation in the usual household refrigerator.

Q. Is there any sublimation where the refrigeration is effected by water ice and salt?

A. No, sir.

Q. In your testimony you spoke of Osborne's "Rather extraordinary claims," as to the value of carbon dioxide as a refrigerant. What were those extraordinary claims?

A. He claimed by rather curious and involved mathematical calculations that carbon dioxide, whether as a liquid or a solid, would take up more heat than what I thought was generally ascribed to it in the state of the art at that time.

Q. You do not remember what those claims were?

A. Yes; I think he claimed for the liquid that it would take up about three or four times more heat than it was generally supposed that it would.

Q. Did you find Osborne's claims borne out by your experiments?

A. I did not find them borne out. I found to the contrary.

Q. Do your notes here in Defendant's Exhibit G give the cost of solid carbon dioxide?

A. I think not, no, sir.

Q. You attempted in your 1905 experiments merely to get the heat exchange value of the solid carbon dioxide and the water ice?

A. Merely to get the value in dollars and cents at the market of that time. We know the market, or how much it cost to do a certain amount of work, and we determined by that experiment how much it would cost to do a certain amount of work by the ammonia system, as the market for [fol. 129] doing that work at that time was established, the market for taking up so much heat, so many B. t. u's, was established at that time, and then we found that it would take a certain amount of CO_2 to do the same amount of work, and the market on CO_2 at that time, while not actually known to a dollar what would be the cost to produce a pound of CO_2, yet that could be estimated within reasonable limits at that time.

Q. You have referred apparently to your St. Louis experiment. I was referring to your experiment with regard to the Osborne matter.

A. The same thing would apply, except the comparison was between water ice and CO_2 ice.

Q. You did not ascertain the cost of solid CO_2 for your experiments in the Osborne matter?

A. Oh, yes, estimated.

Q. Is it in the memorandum?

A. It is not in the memorandum, but I remember distinctly estimating it at that time.

Q. At that time there was no market for solid carbon dioxide, was there?

A. Oh, no. It was not sold. We were trying to find out whether there would be a market for it.

Q. And the Osborne system did not intend to use solid CO_2?

A. No, he did not intend to use solid CO_2. He might have been able to use CO_2, though, although he did not contemplate it.

Q. Did you, in 1905, or whenever these experiments occurred, after you conducted the experiments, consider that solid CO_2 could be used as a practical refrigerant in the place of water ice in the ordinary refrigerator?

[fol. 130] A. That was the object of the experiment, and I did so consider it—I did consider the question.

Q. And your report was adverse?

A. The report was adverse purely as a matter of cost.

Q. You did not report to your principals the possibility that a pound of carbon dioxide ice would do the work of much more than two pounds of water ice, did you?

A. No, I do not think that I even made that comparison. I simply made the comparison that it would cost—yes, I did too. I stated the amount of CO_2 ice that was used and the amount of water ice that was used to produce the same results.

Q. And your conclusion was that a pound of carbon dioxide ice would do the work of approximately that of two pounds of water ice?

A. Yes, approximately that, yes, sir.

Q. You attended the last monthly meeting of the American Society of Refrigerating Engineers held on December 6, 1927, at the Astor Hotel, and heard a paper read by Mr. James W. Martin, Jr., did you not?

A. Yes, sir.

Q. You participated in the discussion?

A. I did, sir.

Q. I call your attention to the first two paragraphs of the discussion, in which appears to be your comment on Mr. Martin's paper, which read as follows:

"Discussion.—John E. Starr was the first one to comment on this paper. He believes that the question of dry ice refrigeration on as large a scale as railway car work is rather remote, but stated that he thought the author had [fol. 131] clearly indicated the other uses; namely, wherever the saving in the cost of the entire operation (freight, handling, shipment, convenience) exceeds the cost of refrigeration itself.

"Where a definite amount of refrigeration is expected, he had been unable to understand how a substance which has about twice the thermal value of ice could be used to

take the place of any other method of refrigeration, commercially. This would apply to any class of refrigeration outside of the special ones which he mentioned, where the collateral expenses of the total operation are not in excess of the cost of refrigeration even when the extra insulation of the gas is considered."

Does that contain the gist of your remarks at that time?

A. It does.

Q. Do you still subscribe to the view that you expressed there?

A. Certainly; I always have.

Q. You have followed the development of the business of the Dry Ice Corporation very closely, have you not?

A. I have followed it, yes, sir. I would not say very closely, but I have kept track of it.

Q. And you have been in frequent consultation with the officials of the Dry Ice Corporation?

A. I have met them frequently.

Q. Did you submit a report to one of your clients about two years ago that was definitely unfavorable to the use of solid carbon dioxide?

[fol. 132] A. Not to the general use of carbon dioxide. I never made such a report to anyone.

Q. As to any particular use?

A. Yes, sir. I reported it was not suitable for certain uses, it was not a good thing to use for certain refrigerating purposes, and it was a good thing to use for certain others, that is, commercially.

Q. That was about two years ago?

A. I think that first time—the first time I reported on it was, I believe, before the formation of the present Dry Ice Company, at least, before I came in contact with Mr. Martin. I think it was called the Prest Air Company at that time.

Q. After you came in contact with Mr. Martin and had discussed it with him did you change your report?

A. No, sir; I have the same opinion still.

Q. Did you change your views?

A. No, sir.

Q. Did you not go to Mr. Martin and ask him for information as to why solid carbon dioxide, as used by the plaintiff here, had a higher refrigerating value than you had been led to expect?

A. No, sir; not exactly that. I discussed with Mr. Martin the probability as to how much the gas which is formed when solid carbon dioxide is evaporated, how much that gas contributed to the refrigeration of the solid carbon dioxide. It had nothing to do with the heat taxing up properties of the carbon dioxide, but simply as to how far it went in the way of insulation, the same as you put any other insulation around carbon dioxide.

[fol. 133] Q. That was a matter upon which you were not informed at that time?

A. Not fully, no, sir; nobody was exactly.

Q. During the period in which you have been associated with the refrigerating industry, was ice cream manufactured and sold commercially and shipped from point to point under refrigeration with ice and salt?

A. Yes, sir.

Q. And you have known of solid carbon dioxide for over 35 years?

A. Yes, sir.

Q. Prior to 1924 had it occurred to you that solid carbon dioxide could be used as a practical refrigerant in transmitting ice cream?

A. I do not know that the thought was original with me. I think it was a matter of general knowledge that it might be used.

Q. Did it occur to you prior to 1924 it could be so used?

A. I say it did not occur to me. It was known generally in the trade that it might be used, anything might be used.

Q. Did you do anything about it?

A. No, sir.

Q. You did not proceed to attempt to exploit any such idea?

A. No, sir; of course not.

Q. Did you know anybody else prior to 1924 who used solid carbon dioxide in commercially shipping ice cream from point to point?

A. No, sir; I know of nobody who carried on a business of that kind prior to 1924.

Q. As I understand your estimate in these St. Louis experiments was that the price per pound of solid carbon dioxide was 6 cents, is that right—here is your memorandum?

A. Yes, that was a rough estimate of about what it could be made for. I do not know whether it was accurate or not, [fol. 134] but it was the best estimate we could make as the market existed at that time.

Mr. Kerr: Cross examination closed.

Mr. Darby: Just one question.

Redirect examination.

By Mr. Darby:

Q. What effect has carbon dioxide gas on foodstuff?

A. It has on most foodstuffs—it depends a good deal on the average run of foodstuffs. It would have no—to put it negatively—it would have no bad effect.

Q. How long have you known that about carbon dioxide gas?

A. 30 years.

Q. Would it have a preservative effect?

A. On some things there is some evidenceto believe that it has a beneficial effect, a preservative effect—that has been known for a long time.

(Witness excused.)

OFFERS IN EVIDENCE

Mr. Darby: If your Honor will permit, I will offer in evidence these patents. I have two short fact witnesses.

You asked me a minute ago whether Mr. Starr's prior use was pleaded as anticipation and I told your Honor yes. It it pleaded as anticipation of what we understand plaintiff to contend for their patent.

The Court: He did not testify as to any container, he only testified to his knowledge of the solid carbon dioxide.

[fol. 135] Mr. Darby: Rather than putting an expert on the stand I can save your Honor's time by calling your Honor's attention to particular lines in the patent as we go along.

The Court: All right.

Mr. Darby: I offer in evidence British patent No. 13,684 of 1891, to Tichborne, and call your Honor's attention to

page 2, line 29, the patent being for the production of solid carbon dioxide.

(Marked Defendant's Exhibit H-1 in evidence.)

Mr. Darby: I now offer in evidence British patent No. 7436, 1895, to Elworthy. This patent likewise describes a machine for producing solid carbon dioxide, and on page 6, line 22, it reads:

"By the use of this solidified gas, all danger from bursting storage vesels, is done away with, and also the large amount of freight now paid for the transport of these vessels, the weight of which is from 2½ to 3 times the weight of the liquefied gas with which they are charged. The solidified gas can be carried in simple felt bags, or bags of other non-conducting material. It can also be stored or transported in an ordinary ice box, or in the improved form of ice box now to be described."

And it proceeds to describe a particular form of ice box, and then goes on with the following:

[fol. 136] "These improved ice boxes are made with either double or triple walls. The walls may be of metal, or glass, and these may be so secured together that the joints are absolutely air-tight. The walls should have as few points of contact as possible. The space between the walls is now exhausted, and the highest possible vacuum produced, either by Professor Dewar's method, or any other method capable of giving a very high vacuum. In order to protect the box from injury, and to further increase its non-conducting power, the box may be enclosed in an outer case of wood, paper boards, or any other strong non-conducting material, or of metal, and if preferred the space between this outer box and the internal one may be filled with non-conducting material. By these improved means of preparing, and transporting, solidified carbon dioxide, this material will be rendered available for all, or nearly all, purposes for which ice is now used, as well as

for many other purposes for which the latter is unsuitable."

(Marked Defendant's Exhibit H-2 in evidence.)

Mr. Darby: The next patent is United States patent Elworthy, No. 579,866, and substantially the same statement is made in this patent of 1897, beginning on page 2, line 130.

[fol. 137] (Patent marked Defendant's Exhibit H-3 in evidence.)

Mr. Darby: The next is a French patent No. 333,181, of 1903, with translation. The apparatus here shown is in the nature of an ice box, liquid carbon dioxide is brought out from the bottom and comes down through the bottom of the container, partially solidifies, evaporates and goes up to the top, and down through the bottom, where it permeates through the ice box. The material first solidifies in the chamber and then evaporates, and the gas goes through the ice box and forces warm air out through the holes O.

(Marked Defendant's Exhibit H-4 in evidence.)

Mr. Darby: The next is a French patent No. 344,957, of 1904. I merely call your Honor's attention to the second paragraph of the translation, which reads:

"By the evaporation, the liquid carbonic acid, as is also known, is solidified into a snowy mass and can be maintained in this form for shipping, without great difficulty, provided care be taken to maintain a sufficiently low temperature."

(Marked Defendant's Exhibit H-5 in evidence.)

The Court: "Sufficiently low temperature" for its transfer.

Mr. Darby: Yes. The next is British Patent No. 2450 of [fol. 138] 1906 to Elworthy, and I call your Honor's attention to page 2, line 25. This patent is for an apparatus for producing solid carbon dioxide and after describing it he says: "Having obtained the liquid cooled as above, it is

then drawn off into the molds above described, wherein it is solidified.

"The molds may be of any required form, but are preferably made with a slight taper, being slightly wider at the top, so as to allow of easy extraction of the solid."

(Marked Defendant's Exhibit H-6 in evidence.)

Mr. Darby: These foregoing patents have been put in for the purpose of showing the production of solid carbon dioxide, and the next few patents refer to refrigerator structures which we say are anticipations of the patent in suit. I offer patent No. 236,906, to Mosler & Ladewig. That your Honor will see is a shipping box or ice box containing the compartment C and the ice chest D and the patent states that the ice chamber D has full access to the drawers. Butter is placed in the drawer C and ice in the chamber D.

"The lid or door of the box A is closed, and the butter may then be sent to market or stowed away for use. The cold air refrigerated by the ice in chamber D reaches every [fol. 139] part of the same and passes through the channels b of the drawers to the butter, which is thereby kept cold and hard and in good condition."

Your Honor will see every compartment is in direct contact with the ice, merely illustrating that type of structure.

(Marked Defendant's Exhibit H-7 in evidence.)

Mr. Darby: I next offer United States patent No. 533,794, 1895, to Drummond, which is one of the patents, the drawing of which is reproduced in "Ice and Refrigerator", 1895, and if your Honor will refer to Fig. 3, that is an inverse of the structure here, the material is put in the compartment 7, and ice is put all around it.

(Marked Defendant's Exhibit H-8 in evidence.)

Mr. Darby: I next offer in evidence United States patent No. 1,130,932, to Rumple, 1915. This is a lunch box. Referring to Fig. 3, there is an ice compartment, put ice through the cover 7 in the ice compartment 4, and the foodstuff you want to keep cold in the container of the compartment.

(Marked Defendant's Exhibit H-9 in evidence.)

Mr. Darby: Bearing on what the defendant is doing, I call your Honor's attention to the Emmens patent of 1900, No. 652,759, particularly line 37:

[fol. 140] "In order to conveniently transport and use the said blocks in a preferred way, they are put in cases or jackets of felt lined wood or other partially heat-insulating material, by means of which the cans are protected from injury during transport and the cooling power of the blocks is regulated as to speed of action",

and so forth. I do not believe this patent specially mentions carbon dioxide, but refers to the production of a refrigerant in portable blocks which are shipped in exactly the same way that defendant ships its products to its customers.

(Marked Defendant's Exhibit H-10 in evidence.)

Mr. Darby: This patent has expired, but referring to Claim 1 of the previous patent, it is the only thing the defendant is here charged with doing.

The next patent is to Josephson, No. 1,515,119, application filed October 3, 1922. That shows a method of refrigerating water, drinks of that nature. The gas is supplied into the cone shaped thing 6, which is immersed in the water and the gas comes down through the bottom, expands and forms snow, comes through the bottom, goes up through the snow and escapes from the top. Expansion makes the cup cold, as described.

(Marked Defendant's Exhibit H-11 in evidence.)

[fol. 141] Mr. Darby: The next patent is put in solely for the fact of showing the preservative action of CO_2 gas coming in contact with food. It is No. 256,299, of 1882. Line 35, for example, reads:

"I have discovered that almost absolute preservation of putrescible bodies can be accomplished by subjecting them to the influence of carbonic oxide or similar decay preventing gas reduced to an abnormally low temperature."

In other words, the gas given off, enabling it to be used with foodstuff, is inherent in carbon dioxide.

(Marked Defendant's Exhibit H-12 in evidence.)

Mr. Darby: The next patent is U. S. patent No. 1,133,299, of 1915, to Lundin, which is for a Balsa wood refrigerating box. Line 36 reads:

"I have discovered that a heat insulating structure such as that to which my invention relates may be constructed wholly of Balsa wood, which single material or element combines the two functions above referred to, that is to say, the functions of furnishing the mechanical strength by which to hold the structure together permanently and of furnishing the insulation or non-heat conducting effect necessary to refrigeration to a degree at least equal to the [fol. 142] degree of insulation attained in the best constructed cork or fibre insulated refrigerators."

(Marked Defendant's Exhibit H-13 in evidence.)

Mr. Darby: I next offer in evidence United States patent No. 1,421,176, of 1922, to Cremieu. It is put in merely as showing another form of device using solid carbon dioxide. CO_2, or a solid block, is put in a handle, the idea being if you want a carbonated ice drink you put that handle in the glass, and shake it around, and you get your iced drink.

(Marked Defendant's Exhibit H-14 in evidence.)

Mr. Kerr: I object to the Tichborne patent No. 13,684 of the British patents, and to French patent No. 34,957 and to U. S. patent No. 533,799, as not being set up in the answer.

The Court: They can be received to show the prior state of the art, not for anticipation. If they are not alleged in the answer they cannot be received for anticipation, but may be received to show the state of the art.

Mr. Darby: I will check that up. It is patent No. 13,684 of 1891.

The Court: You can look it up and call my attention to it in a memorandum if you want to.

[fol. 143] Joseph P. Lavigne, called as a witness on behalf of the defendant, being duly sworn, testified as follows:

Direct examination.

By Mr. Darby:

I reside at Detroit, Michigan. By occupation I am a practical master mechanic and designer. I have been engaged in designing work about 40 years.

Q. Have you had anything to do at all with designing apparatus for using solid carbon dioxide as a refrigerant?

A. Yes, sir. That matter was brought to my attention during the first part of 1923.

Q. I hand you original letter and an envelope, the letter is addressed to Mr. Miller. Did you write that letter?

A. Yes, sir. That letter enables me to definitely fix the time when the matter of using solid carbon dioxide as a refrigerant first came to me. I can give you the month, but not the date. It was January, 1923, when it was first brought up to me.

Q. Please relate the circumstances.

A. A couple of gentlemen, Dr. Lathrop and Mr. Bright, came to me the first month of 1923, with a box that is on the table over there.

(Mr. Darby produces a box.)

A. (Continuing:) That is the box they brought in. They had been introduced to me by Mr. Jack Knight, an old friend of mine, who knew what my business was, and finally [fol. 144] these gentlemen, Dr. Lathrop and Mr. Bright, opened this box and brought in an iron cylinder containing CO_2 gas. They attached the cylinder to this box by a little copper tubing, and they showed me that they made a white substance in this box by opening the valve from the cylinder which contained CO_2, as I was told, and showed me ice. They also took a skin of chamois, formed a ball by rolling up the chamois, and put the tube in the chamois, and by holding same tight and releasing the gas in the cylinder, in a very few minutes a great big ball formed inside, which was a solid. They opened the chamois and showed me that they had snow. I took some of the snow in my hands. I did not know what it was, I never knew anything about CO_2 before, and I let it lay in my hand a little too long, and it burned me. That was the first I knew about CO_2.

Q. Why did they bring this CO_2 gas to you?

A. They brought it to me to make some containers for the purpose of shipping various things, shipping ice cream, or shipping foodstuffs. They said they wanted some containers made to do that, and they also said that they wanted some made to go into an ice box where they could deposit this CO_2, or snow, in there through a tube in some way, and that was the instruction I got when I started to work to make various containers.

I mailed this letter myself. It has not been in my possession since the time it was mailed. The Mr. A. L. Miller referred to is a promotor from Syracuse. His interest in the matter in 1923 was for the purpose of securing capital to exploit these various things that were to be made.

[fol. 145] Mr. Darby: I offer the letter and attached envelope in evidence.

Mr. Kerr: I object to it as simply the unsupported statement of the witness, and as a self-serving declaration, so far as he is concerned.

The Court: Overruled.

(Marked Defendant's Exhibit I in evidence.)

Q. After this box was left with you by these gentlemen, you examined it and studied it in connection with your taking up the design of the apparatus they asked you to design?

A. I did.

Q. And is this the identical box that was left with you at that time?

A. That is the very box that was left with me.

Q. Has it been in your possession ever since?

A. Yes, up to the time someone came there and got it.

Q. Someone from my office?

A. Yes, sir. Three or four months ago.

Q. Will you please describe this structure and point out the different parts and what they are used for?

A. This structure is made first of wood on the outside, then a line of cork about 1½ inch deep set around a copper box; the outside copper box has a space between, I should say, about one inch, between the outer side of the copper box and the inner side of the copper box, it has also screening wires that make part of the inner copper box. There is a

little tube on the outside here that extends into the space between the inner and outer copper box. There is also a [fol. 146] basket, which can be inserted in the middle of the inner copper box. This basket is, or was, designed, I believe, for the purpose of putting something in there to be frozen. The basket is of copper also. They put in water to demonstrate this to me, and by shutting the cover, which also contains cork, they let in the CO_2, it made snow, because there are a couple of slides on top of this so you can see how much snow is there. They opened the slide, they showed me the snow was deposited between the inner and the outer box, and then closed the box, and a few minutes, I guess it was about ten minutes, they opened the box again and we found that the water that had been deposited in here had turned into ice.

Q. Did you operate that box more than the one time?

A. Lots of times afterwards.

Mr. Darby: I offer the box in evidence.

Mr. Kerr: I object, immaterial to any issue here.

The Court: Overruled.

(Marked Defendant's Exhibit J in evidence.)

Q. Then, what did you do with these gentlemen, did they retain your services?

A. I told them I did not know anything about this stuff and I could not be of much use to them. They took exception to that, and they told me they knew I could do something for them. I finally agreed to look up the art up to that time as to that gas, acquaint myself with it, and then if I could understand it and do anything for them, I would do it, so in my library I found a hand book. The Sloan [fol. 147] Hand Book, I think it was published in 1900, and I read that considerably, and found practically what CO_2 was, because it is well defined in that book, and from that on I found it was easy enough to produce insulated containers, so I made a few sketches and proceeded to make various styles and shapes of containers. Some of these containers were made to put in ice boxes in the place of the water ice, some of them were made to put ice cream in for shipments. I have made drawings and sketches and had my draftsman make drawings for me, and the work went on that way for somewheres around 2 or 2½ years.

Q. Confining ourselves first to the question of the refrig-

erator, before making any apparatus did you make any drawings?

A. Yes, I made some sketches.

Q. Is this one of the sketches that you made?

A. Yes, sir.

Q. And you made that drawing yourself?

A. Yes, sir.

Q. When?

A. About February. This was made October 27, 1923.

Q. That particular sketch was made in October?

A. Yes.

Q. Is it signed by you?

A. Yes, sir.

Q. And the date is there with your name?

A. Yes, sir. I have not touched that since that date.

Q. You likewise placed this drawing in the possession of my representative, did you not?

A. Yes, sir.

Mr. Darby: I offer the drawing in evidence.

[fol. 148] Mr. Kerr: Objected to as immaterial and incompetent.

The Court: Overruled.

(Marked Defendant's Exhibit K in evidence.)

Q. Will you please describe the structure shown on that drawing?

A. The container is made of tin. It is an outside circle made of tin, the same as you would make a stove pipe, and two covers are put one on each end. In the middle of the tube, after the covers have been put on each end, a flat tube, somewheres around 2½ to 3 inches wide, was made, one and a quarter inch thick, and it was put through there, and there soldered to make a space for what we used to have, a tray—I have not got the tray, but we made a lot of them. This tray was inserted in here in this middle flat tube practically the whole length.

Q. Is this what you refer to as a tray? (Showing the witness a model.)

A. No, that is the tube. In the back end of this cylinder which had heads on was located a nozzle, an expanding nozzle. This expanding nozzle was connected by a tube to

a cylinder containing CO_2 gas with a valve mounted on the same to allow the CO_2 gas, which was in a liquid form at that time, to expand into this tube or cylinder that had the two covers, which was somewhere around 8 inches in diameter, and 9 or 10 inches long. This allowed a large vacant open space inside the cylinder whereby the CO_2, by being let in there, would expand, and it would expand, and during the expansion it would form a snow, a certain amount of it—as to the amount I do not know. We could fill this prac- [fol. 149] tically almost full by the CO_2 gas we allowed to escape into this compartment. We then closed the valve when we thought it was full, and closed the ice box this was in where there were foods and apples and different things, and water in there for different purposes to be refrigerated, that is, cooled.

Q. You say you actually built ice boxes employing that?

A. We did not build the ice box, but we built the containers to put in the ice boxes. We built around 25 or 30 of them.

Q. What was done with them?

A. Some were sold, some were used for promotion purposes.

Q. Have you a photograph of one of these ice boxes?

A. I have. That is one of them (indicating).

Q. When was that photograph taken, if you know? Is there any mark on it that will enable you to state?

A. It says May, 1924.

Q. Is that your handwriting?

A. No, that is not my handwriting.

Q. Can you state definitely when one of those ice boxes was completed with respect to the date of that drawing?

A. Somewhere in the year 1923. We kept making them right along from the time I was engaged until a year and a half or two years after that—practically a continuous performance.

Q. I notice in the photograph that the container that you built was put in the ice compartment of the ice box, is that right?

A. Yes.

Q. And I notice at the top of the container there seems to be a nozzle. Does gas escape from that nozzle?

[fol. 150] Mr. Kerr: I object, leading.

The Court: What was the purpose? What did that allow?

The Witness: That allowed the gas to escape.

Q. Into the ice box proper?

A. Into the ice box proper.

Mr. Darby: I offer the photograph in evidence.

Mr. Kerr: I object, it is too late in date, and also not identifying the same structure shown in the sketch.

The Court: I overrule the objection. I allow the exhibit.

(Marked Defendant's Exhibit L in evidence.)

Q. What was the name of these people you were working for, were they incorporated?

A. They were not incorporated at that early time. They were Dr. Lathrop and Mr. Bright and Dr. Applegate. They had some understanding amongst themselves. I did not know anything about their organization. I think the name they ultimately incorporated under was the Refrigerator Products Company.

Q. I hand you this sheet of paper and ask you if you know what it is?

A. That is the company.

Q. What is that, is that a paper you have had in your possession?

A. Yes, sir.

Q. And on the second page of that folder appears to be a reproduction of a letter from you to that company, dated February, 1924. Did you write that letter?

[fol. 151] Mr. Kerr: I object. That is not his original letter. It is a reprint of something he had nothing to do with.

The Court: Then he knows nothing about it, does he?

Mr. Darby: Yes, it has been in his possession. It is the prospectus of this company. The companies go back to 1923.

By the Court:

Q. How long have you had it in your possession?

A. I had those from the time they were printed.

Mr. Darby: They must have been printed subsequent to February, 1924.

The Witness: Yes, 1924.

Q. You have had it in your possession since 1924?

A. Not continually, but we had a lot of them down there. That is one of them.

Q. You have had that since 1924?

A. Yes, sir.

Mr. Darby: I have asked the witness if that prospectus shows a letter from him to the company, dated February, 1924, and asked him if he wrote such a letter, if he recognizes it.

The Court: You can ask him by looking at this paper if he can refresh his recollection. He could refresh his recollection from anything, from a newspaper, I presume.

The Witness: I remember writing the letter perfectly, [fol. 152] but as to the date I cannot remember.

Mr. Darby: I offer the circular in evidence.

The Court: I am going to take it, but I do not think I would take it generally. I do not think that proves the letter.

Mr. Darby: I do not care about the letter.

The Court: I will take it as showing the company was formed at or about the time he says it was formed.

Mr. Darby: That is the whole purpose of the exhibit.

Mr. Kerr: That is during the year 1924 sometime.

The Court: He said he had that in his possession since 1924, and that the company was formed before he had that paper.

Mr. Darby: Yes, sir.

(Marked Defendant's Exibit M in evidence.)

By Mr. Darby:

Q. Did you make any drawings of ice cream containers?

A. Yes, sir.

Q. Have you any other document which enables you to be positive as to the time when you were doing this work on refrigeration with solid carbon dioxide?

A. I have in your file a copy of a letter which I wrote and kept a copy of, which verifies my time of 1923.

Q. A typewritten letter?

A. A typewritten letter.

[fol. 153] Q. You dictated it yourself?

A. Yes, sir.

Q. Where has this copy been from the time it has been made?

A. In my files.

Q. Is this the letter you referred to?

A. Yes, sir.

Q. What is there about that letter that enables you to fix the time?

A. On account of the bill, which shows a check was sent to me for part of my time up to that time.

Q. Please read that.

A. "I thank you very much for your check for $300 which was certified and made it possible for us to get the money. Now there is a balance due of $621.16 to the 29th day of November."

Q. What is the date of the letter?

A. January 2, 1924.

Q. What were your arrangements as to how you were to be paid?

A. I was to receive $2 an hour from the first company, that is a co-partnership.

Q. With your recollection refreshed by having read this letter, can you tell us what was the financial position of yourself and the company as of November, 1923?

A. Up to that time they sent me a check for $300, and there was still a balance of $621.16. At $2 an hour that would put it back quite a little from the date of this letter.

Q. I notice the letter is addressed to G. J. Burns, care of Burns Brothers, Stock Exchange Building, Philadelphia. Who was he, and what connection did he have?

A. He was the successor of the company that was organized in Chicago, and he was the president and general manager of this new company.

[fol. 154] Q. That is the Refrigerator Products Company?

A. Refrigerator Products Company.

Mr. Darby: Now I offer that in evidence.

Mr. Kerr: I object to it as incompetent, merely the unsupported statement of this witness.

The Court: Overruled.

(Marked Defendant's Exhibit N in evidence.)

Q. Now, you mentioned in your examination a little while ago your work also involved the designing of a container for shipping ice cream?

A. Yes, sir.

Q. When did you complete your work in that connection?

A. The container for shipping ice cream, which was a quart container, both in the square and in the round, that is, the one in the round was for bulk, and the container in the square was for brick. I worked on that about three months before I made a blue print showing both of them for the purpose of getting them manufactured and getting prices from those who made paper boxes.

Q. What was the container designed for with respect to a refrigerant?

A. It was designed to put ice cream in the container, and then make a brick of CO_2 to put on top to keep the cream cold in case you sent it a long distance.

Q. Now, are these blue prints which I hand you the drawings you referred to?

A. Yes, sir.

Q. When were they made?

A. They were made in the sixth month, 15th day, 1924, by Mr. Dixon, my draftsman.

[fol. 155] In whose possession have those blue prints been since that time?

A. Mine.

Mr. Darby: I offer the blue prints in evidence, the first one for the square or rectangular container, and the second one for the circular container.

Mr. Kerr: Objected to as incompetent and immaterial, as proving nothing commercial, and also being dated some six months after the application for the patent was filed, which was filed January 10, 1924.

The Court: I will overrule your objection now and will see about it later.

(Marked Defendant's Exhibits O and P in evidence.)

Q. What was done with the ice cream containers, that is, did you just draw them up and stop there?

A. No, I think we got 500 containers made, and Mr. Bright, one of the incorporators of this company, or owner of the company, used them for demonstrating and securing capital, and I presume he told me he sold some of them.

Q. Were the containers manufactured after the making of the blue prints or before?

A. We made a lot before that.

Q. How long before?

A. Five or six months. The blue print was made for the purpose of using it for securing capital. That is why they were made in that shape. We worked on sketches altogether to make the first ones.

Q. In your testimony you referred to this metal box which I hold in my hand as a tube?

A. As a tube, yes, sir.

[fol. 156] Q. Referring to Defendant's Exhibit K, is the tube shown in there?

A. Yes, sir.

Q. Will you apply reference letter A in lead pencil to the tube?

A. I have done so.

Q. Is this one of the tubes that were actually used?

A. That one was not used, but there were a number of them made.

Q. This has been in your possession since when?

A. Since we made them in 1923.

Mr. Darby: I offer the tube in evidence.

(Marked Defendant's Exhibit Q. in evidence.)

Cross-examination.

By Mr. Kerr:

Q. Mr. Lavigne, when was it you started to work for the Refrigerator Products Company, or Mr. Bright and his associates?

A. They came to see me in January, and I started to work, I think, the first part of February. I fix that date by my correspondence.

Q. You, in answering the last previous question, did not give the year?

A. 1923.

Q. Who was it that came to see you at that time?

A. Mr. Jack Knight, Dr. Lathrop and Mr. Bright. Mr. Hedican was running the car for them, he was chaffeur for these gentlemen. I did not see him the first day. He may have been there, although I have seen him lots of times since then.

Q. He did not come and talk to you then?

A. I think not. I think Jack Knight came first and Dr. Lathrop and Mr. Bright. Mr. Hedican may have come in. I did not notice him.

Q. You are perfectly sure you wrote and mailed this [fol. 157] letter on May 23, 1923?

A. I must have.

Q. Why?

A. Because that is my writing, my signature there, and it is under that date.

Q. Who was it changed this date, in this 1923?

A. I do not know of anybody changing the date.

Mr. Kerr: I call your Honor's attention to the fact that the date has been changed to 1923. It is our contention none of these things occurred until 1924. If you look at the "9" you will see there has been a change there.

(The Court examines the paper with a magnifying glass.)

The Court: I cannot say that certainly. The post mark is 1923 on the envelope. The last part is torn, but the 3 is clear on the envelope. There is just as much indication that the figure 1 has been written over, no erasure, that there is an indication as to the 3. It might be the four numerals had been written over.

Mr. Darby: I might say this, that that letter has been in my possession since shortly after this suit was filed, in its present conditions, and was delivered to me by Mr. Miller, who I expected to be a witness here, but he is critically ill and confined to his bed at Rochester. I might want an opportunity to examine him on that.

Mr. Kerr: I think that in the round mark the thing your Honor says appears to be 23 is the day of the month and [fol. 158] not the year, whereas there is a 24 on the envelope there, which may well be the year. I am not certain that this is done by a hand stamp at the same time.

The Court: I am not certain that is a 4 either.

Mr. Darby: If Mr. Kerr wants additional proof I have all this pile of original documents beginning April, 1924, and running through the year, that I am willing to prove by this witness.

Mr. Kerr: We are not interested in 1924, your Honor.

The Court: If you raise any question about it I will let him take the testimony of the man who is sick, because that is a pretty serious imputation you are making now.

Mr. Kerr: We make it advisedly, your Honor.

The Court: If that is so, I will let them have an opportunity to examine the man who is sick, who is supposed to have received the letter.

Mr. Kerr: Did I understand Mr. Darby to say he got this letter from Mr. Miller?

Mr. Darby: Yes, Mr. Miller direct, shortly after the commencement of the suit.

The Court: The imputation you are now raising is something that should not be allowed to stand, and if Mr. Miller is sick, I will give them an opportunity to take his testimony. That is a rather unusual charge.

[fol. 159] Q. Mr. Lavigne, in the body of this letter this speaks of making both the small counter machine—what was that?

A. That is the machine I referred to in my drawing there for making a cake of ice to fit on the top of the containers which are shown in the blue print in Mr. Darby's file.

Q. You were working on that in May, 1923?

A. I was working right along there. There was a little cessation between times there; I think about a month, where they ran short of money, where I was let go on something else for a while.

Q. This work was done in your plant?

A. A. Yes, sir.

Q. All of it?

A. Yes, sir, that is, the paper containers were not made in our plant.

Q. Where were they made?

A. By a box maker in Detroit.

Q. Did you get any made by the Hup Company?

A. I did not get them made. They came and took part of my work and took it to Hup and tested it. That was in 1924.

Q. Who was it in connection with Hup that was interested in this thing?

A. There were two men there interested, the superintendent and the general manager was interested, and I think had some stock in the company. I forgot their names now.

Q. Mr. Nickerson?

A. Mr. Nickerson is one. He is the one that did the finishing of one of the machines I made while I was making others.

Q. He was not interested in the thing at first, was he?

A. I do not know anything about their business.

[fol. 160] Q. When did you first come in touch with Mr. Nickerson in this connection?

A. I should say six or eight months, six months after I first started.

Q. And these things that were done at the Hup plant you think were not done until 1924?

A. The early part of 1924. I know it was cold when we went down there. I went down there to see some of their tests. It is about that time Mr. Miller came into the picture.

Q. Were these the first blue prints you had made of the ice cream packages?

A. I made a lot of sketches before that.

Q. I am talking of blue prints.

A. I do not think I made any blue prints before these.

Q. These were the only ice cream carriers you developed?

A. The other ones that were used in the ice box were containers as well as carriers.

Q. Carriers for ice cream?

A. Not for carrying ice cream, for freezing tubes.

Q. When did you first see any of these carriers for ice cream?

A. I should say sometime in the fall of 1923.

Q. How soon after you made the first sketch you produced here?

A. Soon after that, I guess.

Q. You guess. Can't you state definitely?

A. Soon after that.

Q. How soon after?

A. I should say a couple of months.

Q. You made that first drawing or sketch on October 27, 1923?

A. Yes, sir.

Q. And it was a couple of months after that?

A. I made those blue prints, yes, but I made a lot of sketches before that.

[fol. 161] Q. When did you make the blue prints?

A. It is evidence there, it is marked.

Q. I ask you now to tell me.

A. 1924.

Q. When?

A. I could not remember.

Q. You cannot tell—was it January?

A. I cannot tell.

Q. Was it December?

A. I say I do not know, I do not remember. The best evidence is right on that paper.

Q. You did not put it on that paper, did you?

A. No, my draftsman did.

Q. And your name is not on the paper?

A. No.

Q. When was it this man Miller came into the picture?

A. Just about the time that one of the later ice box containers was designed.

Q. When was that?

A. That was in the early part of 1924.

Q. And yet you wrote this letter to Mr. Miller in May, 1923?

A. Yes, sir, on some other sizes of some other kinds.

Q. You say he first came into the picture January, 1924?

A. I would not say positively on that, whether it was 1924 or 1923, but it was at the time the Hupmobile made the test on the improved square bottom holder of CO_2 for ice box purposes.

Q. So if we had that date we would be all straightened out?

A. It is practically there, I think, in the letters and my correspondence.

Q. How long after you first saw Mr. Bright and Dr. Lathrop and Dr. Applegate did you get in touch with Mr. Miller?

A. I do not know that.

Q. How long after did Mr. Nickerson come into the thing?

A. The only thing I remember is Miller came into Mr. [fol. 162] Nickerson's, and I saw him there the first time when we were testing the improved ice box container.

Q. So that if they did not try out the one that was made at the Hup plant until 1924, this letter was written in 1924, isn't that correct?

A. No, sir, that letter was written on the date shown there.

Q. You entered into a contract with Mr. Bright and his associates, didn't you?

A. A verbal contract, yes, sir.

Q. Didn't you have a written contract?

A. After a while.

Q. When was that?

A. I do not remember when it was. I have the contract in my safe home.

Q. You did not bring it here?

A. No, I forgot all about it.

Q. It did not seem important?

A. I did not think about it. It is the one with the new company organized in Chicago.

Q. The Refrigerator Products Company?

A. Yes; the first contract was a verbal understanding, no contract.

Q. When the Refrigerator Products Company was first organized was Mr. Burns connected with it?

A. No.

Q. How long after that was organized did he become connected with it?

A. I could not say; probably a year.

Q. It was about a year, wasn't it?

A. Yes, about that.

Q. And this circular was, with a letter from you, dated February 27, 1924, with regard to the Refrigerator Prod- [fol. 163] ucts Company, sent out shortly after the Refrigerator Products was organized?

A. I do not know when it was sent out. I know it came into my file in some way.

Q. And this was the company, Refrigerator Products

Company, with which you had a written contract, which is now in your safe?

A. Yes, sir.

Q. So that if the Refrigerator Products was organized in the early part of 1924, you did not get in touch with Mr. Burns until about a year later?

A. Just about a year later, when I found out he was in the company. That is a year later from the time I started to work on that proposition.

Q. Do you remember whether I am correct in stating that your contract with the Refrigerator Products was dated January, 1924?

A. I do not remember what the date was.

Q. Your recollection on dates is not so good?

A. No, because I made so many contracts about those things.

Q. Do you keep books?

A. Copy letters.

Q. Haven't you books to show what you worked on on a certain date?

A. No.

Q. How do you charge off your stuff?

A. This work of mine is simply inventors' help, and you take an article and produce it and charge them.

Q. You have not a time book or shop book showing anything?

A. No.

Q. None at all?

A. No.

Q. It does not show any work on anything else?

A. No.

Q. After these people came to you, Mr. Bright and his associates, how long did it take for you to study up in [fol. 164] the matter?

A. I immediately started to work to study up the matter.

Q. How long did it take?

A. It took me two days to read that book over to get what I wanted to find out—Sloan's Hand Manual—and I do not think they came to see me after they asked me to look that up for a couple of weeks.

Q. Then the next thing you did was to draw this drawing here?

A. That is one of the sketches. I do not know how late that was; that may be one, two, three, four months after they came to see me.

Q. It might be a week or four months?

A. The best evidence is on the sketch.

Q. This is October 27, 1923?

A. That is probably right—it is right.

Q. What is this cap on top shown there?

A. The cap is for the purpose of holding pieces of clay or other substance that will let the CO_2 percolate through and regulate the speed of the evaporation of the CO_2 gas.

Q. It is a solid cap, isn't it?

A. No, it is full of little holes on the side.

Q. What was this first machine made of?

A. Tin. This one was made of heavy tin.

Q. What size metal?

A. I should think it was a little less than 1/32 thick. They brought the tin to me, Mr. Hedican brought it.

Q. Then you made it up in this form?

A. That one that time. The first ones were made out of very thin tin, like tinner's tin, but that exploded shortly.

Q. The first one exploded?

A. Yes.

Q. Why?

A. There was not enough opening for the evaporation [fol. 165] of the gas as the heat came in to expand it.

Q. The pressure in the tank was such as soon as you opened the valve the thing blew up?

A. No, it did not blow up right away. I think blew up about 4 o'clock in the morning.

Q. What was this, the next form?

A. That may be the third, fourth or fifth.

Q. You can't tell?

A. No.

Q. It might be the second?

A. It is not the second, because the second was all made of thin tin.

Q. The second was made of thin tin?

A The first one.

Q. Was the second thin tin too?

A. I guess three, four or five were made up.

Q. Did you sell any of these?

A. No—I had nothing to do with selling.

Q. How many did you make of each?

A. Only one of each of the different forms I made.

Q. How many different forms did you continue to make until you got a satisfactory one?

A. I worked nearly a year on the proposition until I got the square bottom one.

Q. Have you a picture of that?

A. Yes, there is a blue print of that.

Mr. Darby: Here is one.

Q. This was the first one that was really satisfactory?

A. I would not say that. That was the latest that I thought was the right design at that time.

Q. Is that the one that was made at the Hup plant?

A. Yes, sir, that was one of those that was finished at [fol. 166] the Hup plant. There were several of them made.

Q. Was that the first one that was made at the Hup plant?

A. At the Hup plant it may have been the first one, but they changed it a little at the Hup plant.

Q. You think that is the first?

A. It was finished at the first plant. They never made a complete one.

Q. The first one that was finished at the Hup plant?

A. I would not say that—oh, yes, it was the first one finished at the Hup plant.

Mr. Kerr: The date of that is June, 1924, and this letter was written in May, and talks about others.

(Mr. Darby read the letter to the Court.)

Q. How active was Mr. Hedican in this situation?

A. He was very active there for a while, and finally he withdrew from the picture after a while—I don't know when.

Q. When did he withdraw?

A. I could not tell you that. I know he did not stay with the organization very long.

Q. Six months——

The Court: Something should be done with that last blue print.

Mr. Darby: I will offer it in evidence.

(Marked Defendant's Exhibit R in evidence.)

A. I could not tell you exactly. I know he was around there four or five or six months.

[fol. 167] Q. Last fall did you go to Mr. Hedican and ask him what the date was when you began work for Mr. Bright and his associates?

A. I did.

Q. What did he tell you?

A. He told me he did not know, but he was going to try to establish it, and went there the second time to find out if I could confirm my own stuff, and he said he did not remember, and would not go, because he lost so much money he wanted to be paid before he did anything for them.

Q. Did you lose any?

A. Probably $1,000, $5,000 in stock, and probably $1,000 in cash.

Q. The whole thing blew up?

A. Seven hundred and some odd dollars in cash.

Q. The whole thing blew up?

A. Yes, the whole thing blew up as far as I was concerned, but they kept trying to sell the stock. I did not think they were doing the right thing.

Q. What do you mean, they were not doing the right thing?

A. I thought they were selling stock and not producing anything, like a good many other companies.

Q. Do you know how many boxes they sold?

A. No, I shipped the boxes from my factory, and I do not know what they did with them, shipped them to Philadelphia.

Q. That was after Burns Brothers got in it?

A. Yes, sir.

Q. Did you ever come in contact with Mr. Sorensen?

A. Only once, I think.

Q. When was that?

A. Some little time after they brought this wooden box over there.

Q. Did you go to Dr. Lathrop and try to establish the dates through him?

A. No, sir.

[fol. 168] Q. He had the books and things of the company, didn't he?

A. I don't know.

Q. He always paid you, didn't he?

A. No, he was not the one that paid me all the time. He paid me some of the times.

Q. At first he paid you all the time?

A. At first, yes, at the first time.

Q. When did you begin to use clay tubes on the inside of this device?

A. Three or four months, or three months after we started to work on the thing, I found they were using chamois, and chamois I found deteriorated, hardened, and you could not depend on the continuous performance through chamois; consequently I looked for some other substance that would not deteriorate, and I found this Los Angeles clay that could be made in different density, and therefore be able to regulate the flow, or the evaporation of the ice. I got those tubes from the Allen Water Filter Company. I have some of those samples in my box. When I first started out on this first machine I expanded the liquid into that container.

Q. What does this tube represent?

A. That represents that center piece. It is fastened solid to the back end. It runs through, and is riveted over and soldered in. The gas does not get out of it.

Q. Where do you put the thing to be refrigerated?

A. Inside a tray that is slid into that tube. The tube is the thing that is in the middle. The gas does not get into it. It comes in contact with it on the outside.

Q. The gas is on the outside?

A. Yes, the snow—that is practically filled with snow.

[fol. 169] Q. What is this network here?

A. That was a nest of fine netted wire to allow the gas to go through into that very, very little. The tighter we would make that, the less would go in. A little of the gas went into this thing.

Q. This does not show it?

A. This was not finished. The piece was not put on there.

Q. So that, so far as the snow was concerned, it was always on the outside of that tube, or that oblong arrangement?

A. A little of it would go in through the percolating basket in there.

Q. With these clay tubes, where did your snow form?

A. Formed in the container and could not go through the clay only by its evaporation.

Q. It never got out of the clay tube?

A. Yes, it had to go through the clay tube.

Q. The snow did?

A. The gas.

Q. The snow always stayed inside the clay tube?

A. I suppose so. We found a little snow on the hole of the clay tube on the outside that would sift through, some of it.

Q. Since you sent this letter to Mr. Miller you have not seen it until today?

A. No, sir—well, yes, sir, I saw it yesterday.

Mr. Kerr: Cross-examination completed.

Redirect examination.

By Mr. Darby:

Q. Am I correct in understanding, Mr. Lavigne, that you developed the type of refrigerator with the filters which you got from the Allen Company about a year subsequent to the time you developed the first refrigerator, is that your testimony?

[fol. 170] Mr. Kerr: I object. I do not think he said such a thing. He has not a recollection of definite dates.

The Witness: I have not yet, but I think it is five or six months after I started to work for him.

Q. Five or six months after you started to work for him?

A. Yes, sir, that is that last one there.

Q. And you were obtaining filters from the Allen Company, I think you said?

A. Yes, of Toledo. They called those filters the Allen filter.

Q. How long was it after you first began working for them that you began to use filters?

A. In some form I think we began that two or three months after I started to work for them, because that doubled up very quick.

Q. So the filter development came about three months after you started to work for them?

A. Yes, about that time, because I found the chamois and canvas bag was too costly, that is, the gas would go out of it so fast you could not get any commercial use for it. The price would be too high, you know.

(Witness excused.)

[fol. 171] J. C. GOOSMANN, called as a witness on behalf of the defendant, being duly sworn, testified as follows:

Direct examination.

By Mr. Darby:

I reside at 5220 Magnolia Avenue, Chicago. By occupation I am an engineer. I am the J. C. Goosmann who copyrighted and published the pamphlet "CO_2 Ice Therapy."

Q. What work have you done in connection with the use of CO_2 ice or solid carbon dioxide for therapeutical purposes?

A. I have worked with carbon dioxide practically every day of my life since 1897, but this particular line of work started in 1909. Since my college days I have used, in connection with my work, or been familiar with the use of solid carbon dioxide.

Q. With respect to commercial operations or practical uses as distinguished from laboratory work, what has been your connection with the subject?

A. Since practically 1897 I have been interested in the use and the manufacture of carbon dioxide, the manufacture as well as the industrial application of liquid carbon dioxide, or carbon dioxide gas, or solid carbon dioxide, for that matter.

Q. Confining yourself directly to solid carbon dioxide, will you please recite your connection with that particular subject?

A. In mechanical refrigeration we found conditions quite frequently at very low temperatures where carbon dioxide solidified in a closed system, and then our endeavor was to [fol. 172] establish the temperature point at which carbon dioxide crystalized. Much of the property of carbon dioxide gas was not so fully known. It developed gradually, and the knowledge on the subject became more concise and accurate in time. I am personally familiar with the use of solid carbon dioxide in the medical profession.

Q. What connection have you had with that?

A. The dermatologists were trying to use liquid air originally for the purpose of eradicating or correcting skin diseases and skin defects, but the temperature of liquid air was so low that the treatment with liquid air was rather difficult, so they looked for a different medium, and found it in solid carbon dioxide. That was first demonstrated by Dr. Pusey of Chicago, in around 1907.

In 1905 Dr. Darby had a dermatological congress in New York and demonstrated liquid air but carbon dioxide in solid form was expected. In around 1907 and 1908 some of my friends in the medical profession asked me to design an apparatus in a convenient form so they could use it. I perfected that about 1909.

This book which you haud me is "CO_2 Ice Therapy," which was copyrighted by me, according to its fly-leaf, in 1918.

Q. Does that book illustrate the apparatus that you designed for making use of and storing solid carbon dioxide?

A. Yes, sir, it illustrates and describes various instruments and apparatus that were used for that purpose. I am intimately familiar with the facts that are set forth in that book and vouch for their correctness.

[fol. 173] Q. What page does the apparatus you designed for the use of the ice pencil in the medical profession appear on?

A. There are several. One is illustrated and described on page- 20 and 21, and there are some others of simpler form. There is another one on page- 28 and 29, and a third and fourth form on page- 30 and 31.

Q. Will you briefly describe the methods which you disclose there of preparing and storing solid carbon dioxide?

A. This instrument consisted principally of a tube.

There is an outside and inside tube, and between the two tubes is a layer of material, fabric, or chamois leather, that serves the purpose of allowing the carbon dioxide to evaporate through the instrument at low pressure and retaining the crystallized, would solidify carbon dioxide particles inside of the instrument. Then these crystals are filling the instrument in rather loose form, in the form of snow, they are compressed by means of a screw piston so as to obtain a solid carbon dioxide pencil, as we call it. It has the form of the ordinary chalk crayon, a little larger in diameter, and has about the same appearance, unless the carbon dioxide is compressed very thoroughly by a very thorough compression. By means of this screw piston it could be compressed into translucent form, or practically transparent, but that took considerable pressure. The pencil, after forming the compression, is removed from the instrument, and it is then handled by the physician or surgeon who protects his fingers against the intense freezing process by means of gloves or a piece of chamois leather, and the pencil is then [fol. 174] applied either to the skin disease or skin defects, of which there are many varieties, by pressure, and pressure as well as the time of application govern it for the different diseases and different defects. Pressure was necessary to remove the film of evaporating carbon dioxide gas which forms an insulating protection between the ice itself and the tissue, and in order to freeze more deeply into the tissue sometimes quite extensive pressure was needed. All that is explained under an enumeration of the defects and diseases given in this little booklet, which also shows the time of application and the pressure required.

Q. What provision is made for storing the carbon dioxide when not in use, when in solid form?

A. We used different methods. We used the Thermos bottle, and also used very simple wooden containers, just simple wooden containers, in which we deposited the solidified carbon dioxide, or like, in another instrument I made, which was used for a slicing specimen of tissue before staining, to use it under the microscope. I designed at that time a little instrument which is known as the freezing microtome, and this freezing microtome, in order to make it portable to carry from place to place, or from laboratory to the operating room, the apparatus was made self-contained by

forming a pencil and putting this pencil into a hard rubber container. This container was closed at the top with a metallic plate, a microtome plate, and this metallic plate was in contact with the carbon dioxide pencil inside the instrument, and by adjusting the contact between the carbon di-
[fol. 175] oxide pencil and the microtome plate the intensity of freezing of the specimens on top of the microtome plate was adjusted, and this specimen was immediately frozen and could then be put into a slicing machine in which it is sliced in thin layers of about 1/1000 of an inch in thickness. These layers were stained so the process of examining the specimens for various diseases could be carried on in the operating room without sending the specimen out of the operating room down into the laboratory.

Q. When was this done with respect to the date of copyright of your booklet?

A. This was all done during the years 1909, 1910 and 1911.

Q. And had CO_2 Ice Therapy been in use prior to 1918, the date of copyright of the book?

A. Yes, sir, I found in the literature on the subject traces here and there in which carbon dioxide, either in solid form or gaseous form, had been used for medicinal and therapeutic purposes.

Q. So far as your particular work is concerned, is the date of copyright of that pamphlet the beginning of the art, so far as you are concerned with it?

A. No, this booklet was published a good many years later. By that time it had become a commercial article, and there was considerable demand for it, and at that time I wrote this book, but it had been used prior to my connection with it in a rather crude form.

Q. How long prior to the copyright of that book, 1918, had it been used?

A. My work really started on it in 1909.

Q. What did you do with that book that was published?

A. This was sent out to the medical profession to illustrate the process and to show the instrument.

[fol. 176] Mr. Darby: I offer the book in evidence.

Mr. Kerr: I object to it as immaterial.

The Court: Overruled.

By the Court:

Q. What distribution was there of it?

A. The book was reprinted several times. I think the first issue was about 3,000. I distributed it through the mail.

(Marked Defendant's Exhibit S in evidence.)

Q. Did you distribute it among any particular class?

A. We had quite a good many inquiries. It was advertised in some of the medical journals, and the inquiries came in, and then it was sent out.

Cross-examination.

By Mr. Kerr:

Q. Had the use of this medical pencil to which you have referred any other purpose than to destroy medical disease germs by low temperature?

A. Yes, sir, there were other forms of application. For instance, not only in this microtome that I described, but also for the purpose of creating drinking glasses in the form of ice by the application of solid carbon dioxide snow in form. We made molds, and the molds had a space between them, and this space was filled with water and solid carbon dioxide was applied around the mold inside the insulated container, and these water glasses were frozen, they [fol. 177] consisted of ice. They were considered not only a novelty, but had the advantage of increased sanitation, because they could only be used by one person, and a good many of them were made, and were made of solid carbon dioxide. There were many other applications in which solidified carbon dioxide was used commercially in chemistry.

Q. What do you mean, what others?

A. For instance, to establish the congealing point of certain liquids, carbon dioxide going down very low in temperature was a very easy means of using it for that purpose; different oils, for instance were tested in the same way. That was because of the low temperature of the solid carbon dioxide.

Q. Was there any other uses you can think of that you were familiar with prior to 1924?

A. Yes, solidified carbon dioxide was used for carbonating purposes, to impregnate water with carbon dioxide gas instead of using the gaseous medium under pressure.

Q. Is it used as a refrigerant to cool water by putting it in it?

A. It was apparent, and has been apparent, ever since carbon dioxide has been crystallized it was adaptable for all the purposes of using it as a low temperature medium.

Q. Such as putting a block of it in a glass of water and cooling the water off that way?

A. Yes. That in itself did not work so very satisfactorily, because the vapors that were immediately created by the solid carbon dioxide in the water surrounded the solidified carbon dioxide with this jacket, which we found [fol. 178] at that time was of very low heat, and prevented the cooling action of the carbon dioxide in the water. Since the temperature of the water remained rather high, the water without being kept under pressure did not absorb enough carbon dioxide, but by closing the receptacle and allowing the vapors to escape by a pressure that could be regulated, then this purpose was very easily obtained.

Q. So if you attempted to carbonate or cool water with a piece of solid carbon dioxide you would not be successful for both purposes if you put it in an ordinary glass of water?

A. No; the water showed very little temperature reduction in that way.

Q. Did you write a book on the "Carbonic Acid Industry"?

A. Yes, sir.

Q. Did you give any examples of the use of solid CO_2 as a refrigerant in that book?

A. No, I do not think I did.

Q. When did you write that book?

A. That was published in 1906, but I showed the method of producing solidified carbon dioxide and also that it was possible to reduce the temperature of solidified carbon dioxide much below its atmospheric evaporating temperature.

Q. Did you publish a history of refrigeration in "Ice and Refrigeration"?

A. It was published in a number of consecutive articles, but it has not been published in book form.

Q. In that series of articles did you give any examples of the use of solid CO_2 as a refrigerant?

A. This history had not sufficiently progressed, it was still more or less in the dark ages, as we used to call it, when [fol. 179] the science of refrigeration and the knowledge of the properties of gases was not so perfect as it is today.

Q. Then your answer is no?

A. I have not reached that point in my description. These articles have not been completed. I have not been able to write the last couple of years because I have been too busy with other work.

Q. So far as they have been written and published, you have not given examples of the use of solid carbon dioxide as a refrigerant, is that correct?

A. That is correct, yes, sir. In my published discussions of solid CO_2 as a refrigerant, I took into account the heat insulating value of the gas.

Q. What articles are you referring to now?

A. The articles I wrote on the subject, they merely concentrated on the latent heat stored up in the medium.

Q. They did not take into account the heat insulating value of the gas?

A. You could not do that very well, because the comparison we made was between solid carbon dioxide and water ice. There is no vapor that comes out of water ice, and therefore that phase was not entered into.

Q. So you cannot properly compare them?

A. Not on the entire basis of using the solid carbon dioxide for refrigerating purposes. It is the refrigerating work of solidified carbon dioxide that does all of the cooling, or prevention of heat leakage into the refrigerator from outside. The heat value of solidified carbon dioxide, that is only a part of the work, but the insulating value of the evaporated gas surrounding the carbon dioxide in filling in space, that is another element that enters very [fol. 180] largely into the consideration, as it prevents the ready heat leakage from the outside into the refrigerator on account of the low conductivity of the gas.

Q. There is a purging effect that pushes the incoming heat out as the carbon dioxide gas seeks an avenue out of the container, isn't that so?

A. The evaporation of the solidified carbon dioxide creates a slight pressure. If you have a greater pressure inside of a closed space than on the outside, if you open the receptacle, of course the gas will issue out.

Q. One of the articles you wrote on solidified carbon dioxide appeared in "Ice and Refrigeration" in May, 1926, at pages 507 and 508. I hand you herewith the photostatic copy of it. Is that correct?

A. That is correct, yes, sir.

Mr. Kerr: I offer the article in evidence.

Mr. Darby: I have no objection to the article being marked for identification, but I do not think it is admissible in evidence.

The Court: What is the purpose.

Mr. Kerr: It is a discussion of the plaintiff's product to a very large extent, the advantages and supposed disadvantages of it. Inasmuch as he expressed a public opinion of it, I think we are entitled to have it.

The Court: I do not know. You will have the whole length and breadth of the science before us if you keep on. I did not think we were undertaking such a large work.

Mr. Kerr: It is a particular reference to the situation in hand.

[fol. 181] The Court: I will take it.

(Marked Plaintiff's Exhibit 21 in evidence.)

Q. The last part of this article says, with reference to solid carbon dioxide:

"It can do no more than to employ its latent heat of 170 B. t. u.'s per pound plus the temperature of the gas between —110 and plus 30, which, on the basis of its specific heat of very closely .25 will yield an additional heat value of 30 B. t. u.'s per pound, so that its grand total refrigerating heat value cannot possibly exceed 205 B. t. u.'s per pound."

Are you still of the same opinion?

A. That is a matter of calculation. That is the heat carried by the medium. The only difference is the specific

heat of the crystallized medium is not so well known even today, but assuming the crystallized carbon dioxide is cooled down after solidification, which occurs at a temperature of minus 70 degrees, necessarily when it gets into the atmosphere at atmosphere pressure it must cool itself down to the temperature corresponding to atmospheric temperature, which brings it down to minus 110, but then it is necessary to know the specific heat of the crystallized carbon dioxide, which nobody knows as yet.

Q. In the early part of your testimony you made some reference to the formation of solid carbon dioxide in mechanical refrigeration systems. The endeavor there was to avoid such formation, was it not?

[fol. 182] A. Not necessarily. We have temperature work today in which temperatures below —70 degrees are required, and since carbon dioxide solidifies at —69 and a fraction it is necessary to deal with the condition that the gas assumes changing into the solid form at a temperature of —69 and a gauge pressure of about 60 pounds. When these low temperatures are required we use another medium in connection with the solidified carbon dioxide that takes it out of the solid form and reduces still further the temperature of evaporation down to a point below —100. Professor Mitchel in his experiments which he made as early as 1847, I believe, obtained temperatures as low as —140 degrees with solidified carbon dioxide and ether or alcohol.

Q. The temperatures you referred to just now were centigrade, not Fahrenheit?

A. Fahrenheit.

Q. Solidification at —69?

A. According to the latest investigations by our own Bureau of Standards the temperature of crystallization, or what is known as the triple point in which the gaseous agent assumes the three conditions, that is, the gaseous condition, the liquid condition, and the solid condition, and according to their final laboratory tests the temperature of crystallization is at —69 and a fraction.

Mr. Kerr: Cross-examination closed.

Redirect examination.

By Mr. Darby:

Q. Why didn't you, in your book of 1906, mention the use of carbon dioxide?

[fol. 183] A. In 1906 these very low temperatures were rather unusual, but our modern industrialism requires temperatures that go lower than even that. Now, for instance, in the industry of the manufacture of airships, where very low temperatures are encountered at the high region up in the air, it is necessary to establish the temperatures at which the material can be strained, or in which it can be used with safety, and since these temperature points go down very low, it is necessary in industry to provide the testing facilities to test everything with a view of having it meet these extreme conditions, and that is why we are going into it much more now than before.

Q. Were uses for solid carbon dioxide known in 1906, to your knowledge?

A. Oh, certainly.

Q. Was your book you published directed to uses as distinguished from manufacture, or vice versa, or what?

A. I cannot say it was. It merely called attention to the fact that carbon dioxide can be easily solidified, and since it had a very low temperature in solid condition, it would naturally be adapted to various low temperature purposes, but the form might be varied.

(Witness excused.)

[fol. 184] Walter E. Ditmars recalled.

Redirect examination.

By Mr. Darby:

Q. Reference has been made to a paper that you read, or a speech you delivered to some society. What was that society?

A. The Eastern Ice Association.

Q. Reference has likewise been made to the fact that a portion of that speech was reproduced in some paper. What was the name of that paper?

A. Electric Refrigeration News.

Q. Likewise mention has been made of the fact that in the opinion of opposing counsel there is a strict similarity between a previous paper of one Mr. Taylor and your paper you read at that society. What have you to say about that?

A. Mr. Taylor told me if I gave proper credit to him and to "Ice and Refrigeration," that he would have no objection to my using it. I did so. I prefaced my remarks at the Eastern Ice Association, giving credit to Mr. Taylor, and also Mr. Killefer, who wrote the article in Chemical and Industrial Engineering, or "Engineering and Industrial Chemistry." This article in "Electric Refrigeration News" does not reproduce that acknowledgment I gave.

When I decided to go into the business of manufacture and sale of solid carbon dioxide, I sought counsel as to the matter. I saw Cushman, Bryant & Darby, patent attorneys, Washington, D. C. They advised us we would not be infringing. They made an investigation at my request [fol. 185] and expense in June or July, 1926. I did not let the matter rest there with their opinion in the matter. I went to the firm of Darby & Darby, 220 Broadway. I requested them to make a similar investigation, checking the results obtained by Cushman, Bryant & Darby with the same results, that we would not be infringing.

Q. Was it after that you began your operations in this field?

A. Before and after, but we did not begin any operations in the solid CO_2 field until we got Cushman, Bryant & Darby's opinion.

Recross-examination.

By Mr. Kerr:

Q. Your second opinion was rendered in April, 1927, was it, from Darby & Darby?

A. I do not remember the date, it was about then.

Redirect examination.

By Mr. Darby:

Q. Was it before or after this suit was started, do you recall that?

A. I believe the suit was started in April, 1927. I am not positive, but I believe it was, and I know I had conversations with you prior to that, but it is of record, I am sure.

Mr. Darby: I do not have a copy of the report here. That completes our case, your Honor, and I apologize for the length we have gone into it.

[fol. 186] JERRY A. HEDICAN, called as a witness on behalf of plaintiff, in rebuttal, being duly sworn testifies as follows:

Direct examination.

By Mr. Kerr:

I reside in Detroit. I am manager of a branch bank of the Pennsylvania State Bank of Detroit. I know Mr. Lavigne who has heretofore testified. I was associated with him in the venture he has testified about. I became connected with that enterprise about the 1st of September, 1923. I became connected with it through Dr. Lathrop. I was associated with him, Mr. Bright and Mr. Sorensen at that time. Mr. Sorensen was supposedly an inventor; Mr. Bright was a promoter. I fix the date as September 1, 1923, or thereabouts, when I became associated with these men, because I closed a real estate office I was operating on the last of August or the first of September.

Q. After you became associated with Mr. Bright and Mr. Sorensen and Dr. Lathrop what were the first steps with which you were familiar?

A. Making snow from the tank of gas through a copper tube into a chamois.

Q. What did Mr. Sorensen or anyone else get up, any contrivance to use the snow in?

A. There were several small contrivances, but they did not amount to anything. After I came there the box that was exhibited here was built at the time we were with Mr. Sorensen. That is the box, Defendant's Exhibit J.

[fol. 187] Q. How long after September 1, 1923, was that box built?

A. About a month.

Q. What happened after that?

A. Mr. Sorensen claimed to have a special gas, and we seemed to find out he did not have anything, and we left him. He signed an agreement he did not have anything, and anything he had he would not work on it any more, and he left the company.

Q. Then what happened?

A. Through a friend of mine we got to Mr. Lavigne. That was approximately the 5th of October, 1923.

Q. Then what happened?

A. That box was used as a money-getting proposition for experimental work.

Q. State how the box was used. You said it was used as a money-getting proposition.

A. This one here, a tank of gas was connected on to a copper tube, I think it is on the other end of the box, and the valve opened on the gas tank, which shot this gas into that open chamber around a tin pail, which formed a snow, and the box was closed, and of course the little pail froze. I personally got people interested in that scheme.

Q. And they took an interest in the company?

A. Yes, sir.

Q. How did you get in touch with Mr. Lavigne?

A. Through Mr. Knight, a friend of mine. That was approximately the 5th of October.

Q. Did you talk with Mr. Lavigne that day?

A. I did.

Q. When the others went in to see him?

A. Yes, sir.

[fol. 188] Q. What happened after that?

A. The box was exhibited at several places in Detroit, at the Fort Shelby Hotel, in Mr. Bright's room; it was shown Mr. Redwood of the Absopure Ice Company, a demonstration was made at the Absopure laboratory by their refrigeration engineer, Mr. Hayes, and the next move was a sketch made in the Fort Shelby Hotel approximately the 25th of October, 1923, made by myself on a rough piece of hotel stationery, and it was brought to Mr. Lavigne and put on his drafting table. Mr. Lavigne made the drawing, and the original drawing was witnessed by myself.

Q. What did that show?

A. It did not show much. We built a machine out of weak material and blew out three or four of them; the pressure in the tank was too great for the box to withhold, and we finally built one with a heavier steel on a rolled edge so as to hold the pressure. Those forms were made in a foundry. The cylinders were made in a foundry on West Pond Boulevard, because we did not have the device to put the seams in the material. That was along about the first part of November, the 1st to the 15th those were made.

Q. You spoke of three or four that blew up. How long did it take to make those?

A. It would take anywhere from four days to ten days to make one.

Q. And then later you made this heavier one?

A. Made the heavier one later.

Q. Was that the one with the tubes in it?

A. That one we had tubes in.

Q. When was that completed?

[fol. 189] A. Along about the 20th or 25th of November, about a month later than the original sketch we made.

Q. Then what happened after that?

A. It was put into an ice box in Mr. Lavigne's shop and a thermometer put in the box to see how cold it was kept. We used on an average of four or five tanks of gas to keep it cold, four or five tanks, 50-pound tanks. We used as high as five tanks a day.

Q. How much did you pay for the carbon dioxide?

A. At retail 18 cents a pound; wholesale for 9 cents. We bought it from the Liquid Carbonic Company, Detroit. Those tanks held 50 pounds apiece. We had some 20 pounds, 50 pounds and 20 pounds.

I know Mr. Nickerson. He was connected with the undertaking, before we went to Mr. Lavigne. I would say he came about the middle of September, 1923, Mr. Nickerson and Mr. Young, who is now president of the Hup Motor Car Company. Mr. Nickerson was general Works Manager of the Hup.

Q. When did you do business at the Hup Works?

A. In the last part of September we made a set of coils, 12 or 14 inches high, to set into a galvanized tank, supposed to be a brine, but they were made and never used, never tried out.

Q. That was before Mr. Lavigne came in?

A. Yes, sir.

Q. After that, these machines that were built later, when did you first take any of them up at the Hup Works?

[fol. 190] A. After I left they took them up at the Hup Works to have them finished. It must have been the middle of March, 1924. I left in March, 1924.

Q. Why did you leave?

A. We did not get any place; they owed me about $1,700, and it was time to leave.

Q. How did they owe you that?

A. Salary.

Q. Did they pay you salary?

A. They did not pay me anything. They were supposed to have paid it.

Q. Were they selling any of these things?

A. No, sir.

Q. What happened to them?

A. The last I saw of several models, was up in Mr. Lavigne's shop.

Q. And they were never moved out of his shop, so far as you know?

A. They were taken out for demonstration purposes, but they filled them full of gas, and it probably took two or three tanks of gas to get them cold; anyway from 40 to 60 pounds of gas to get snow in them to make them cold.

Q. When was the Refrigerator Products organized?

A. The stock was issued on January 11, 1924. I have my stock.

Q. Is that the date it bears?

(The witness looks at stock certificate.)

A. The 11th of January, 1924.

Q. What business did the Refrigerator Products do, so far as you know?

A. Experimental work, that is all. Mr. Bright was a promoter. He was selling stock.

Q. Was any attempt made to sell any of these machines?

[fol. 191] A. Not before the middle of March, 1924, when I left.

Q. Mr. Lavigne has referred to some paper cartons or ice cream carriers. Did you see anything like that that he made?

A. No, sir.

Q. He said there were quite a number around the plant there made from sketches. Did you see anything of that sort?

A. I never saw them.

Q. How intimately were you in touch with the situation?

A. About seven days a week. I was with Mr. Bright every day of the week from the 1st of September, 1923, until I left, say between the 10th and 15th of March, 1924.

By the Court:

Q. What were you doing particularly?

A. My first duty was to get them capital to start with, which I got for them.

By Mr. Kerr:

Q. How close did you keep in touch with Mr. Lavigne's work?

A. I was in and out of the shop every day of the week.

Q. During the time that you were connected with Mr. Bright and the Refrigerator Products Company, were Burns Brothers connected with them in any way?

A. They were not.

Q. Did you ever hear the name in that connection?

A. I heard it later on. Up to the time I left I had not heard of the name.

Q. Have you any idea how many of these tests were made [fol. 192] on these various forms of refrigerators up to the time you left?

A. How many kinds of tests?

Q. No, the number of tests.

A. I only remember of one actual test with the machine in an ice box. That was up in Mr. Lavigne's shop. Mr. Lavigne came to me last fall to find out what date he first started doing this work. He asked me if I remembered when he drew the first sketch of that first box, that is, those were, I think, his exact words. I was busy at the time and he wanted to know where this model was made. I did not know the name or location at the time, but I know where it is now. I was rather busy and told him he would have to come back some other day. He came back on the 10th of November last year, and I did not want to bother with the

proposition, it had caused me enough grief. I told him I did not care to be bothered with it, and not to bother me any more about it. This first model I referred to is the defendant's exhibit J here in front of me.

All of these various things that Mr. Lavigne built were things that were supposed to go into the ice compartment of an ordinary household ice refrigerator.

Q. That was the only use intended for them?

A. That was the only thing they ever tried while I was with them.

Cross-examination.

By Mr. Darby:

Q. Mr. Lavigne impressed you as sincere in his efforts to fix the dates he asked you about?

A. I do not know whether he was or not.

[fol. 193] Q. You question his sincerity?

A. I am not questioning his sincerity, but my dates are only approximate dates. They are very close.

Q. Did he earnestly endeavor to secure from you such dates as he could?

A. The time he came in I was busy and could not bother with him.

Q. What did he ask you?

A. He asked me if I remembered the date he made the first drawing and I told him I did not know the date.

Q. I think you said you were the one who drew up the first device?

A. Yes, and witnessed it.

Q. Was it in any respect similar to this drawing?

A. Yes, sir.

Q. The same structure?

A. Yes, sir, it was round, the same structure.

Q. This does not happen to be the drawing, does it, Exhibit K?

A. If I have not witnessed it, it is not.

Q. You have no reason to doubt this particular drawing was made by Mr. Lavigne on the date thereon, October 27, 1923?

A. He probably did make it.

Q. The drawing you said you made similar to this was when?

A. It was about the same time. Approximately October 25th, I said.

Q. And the purpose of building an ice box, as I understand your testimony, was for demonstrating the use of the apparatus in an ice box for the purpose of selling stock and raising funds?

A. To raise funds to promote it, to perfect it if it could be done.

Q. To go into business to make and sell to the home user?

A. That is what they intended to do.

[fol. 194] Q. You say you were in close contact with the situation, and part of your business was to effect sales?

A. No, I borrowed the money for them to start with.

Q. What was your capacity with the company?

A. Nobody had any capacity in working; it was experimental.

Q. What were you working for?

A. An iceless refrigerator.

Q. And to sell it to the home user?

A. That was what our idea was.

Q. When you got the ice box constructed with this tank installed, you demonstrated it, I presume?

A. Several people called and saw it in Mr. Lavigne's shop.

Q. I thought you said it was taken elsewhere.

A. This box was taken elsewhere.

Q. Not the ice box?

A. The ice box probably was. It was brought East, I understand.

Q. People were brought to the shop to see it there?

A. Yes, sir.

Q. What people?

A. Mr. Knight, he is a friend of Mr. Lavigne's, and also a friend of mine.

Q. What was the purpose of bringing people there?

A. To interest them in it.

Q. Did you yourself bring people there for that purpose?

A. Not personally.

Q. You only saw two or three people there yourself?

A. Yes.

Q. And it was installed in an ice box?

A. Yes, sir.

Q. What did that ice box look like?

A. A common cheap ice box, common varnish, a small box. No food was put in the ice box.

[fol. 195] Q. What type of container was put in the ice box?

A. Built after the type of the round one, but there was a square face that was built on it to hold it from rocking.

Q. A square face somewhat like that shown in that drawing?

A. There is no square face on that drawing.

Q. On Defendant's Exhibit K?

A. That is the front of the box.

Q. And the box was brought down?

A. It was brought all the way around, the square piece. The square piece probably 4 inches wider than the cylinder with a hole in it to set it in.

Q. That is the last development you are familiar with?

A. Yes, sir.

Q. Did they ever make any of these containers with more than one drawer for ice?

A. Yes, made one with two drawers. That was in the square faced one.

Q. Did you ever see an ice box like this Defendant's Exhibit L?

A. No, sir.

Q. So if that ice box was worked up and put in this form by the company for the purpose of selling stock, or for any purpose, you were not familiar with it?

A. I was not. That was made after I left.

Redirect examination.

By Mr. Kerr:

Q. I wish you would explain a little more in detail why you left.

A. It seemed as though Mr. Bright had a great many people after him for money he borrowed, and the progress of the machine was not getting any place. You put this [fol. 196] apparatus in the ice box and used up two or three or four tanks of gas, and it was time for me to go to work.

I was to get $50 a week, which I did not get. It was stopped, I figured. Meantime, they reorganized a company in Chicago, another one in 1440 Broadway, or 1445, and it seemed to me to be a scheme to get money. That was my opinion.

By the Court:

Q. You did not get it?
A. I still have it coming.

(Witness excused.)

PIERRE F. LAVEDAN, called as a witness on behalf of the plaintiff, in rebuttal, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

I reside at Kew Gardens Road, Kew Gardens, Long Island. I am gas sales manager of the Liquid Carbonic Company. I am a graduate of Massachusetts Institute of Technology. I have been with the Liquid Carbonic Company since 1920. From 1920 to 1922 I was employed as chemical engineer in the engineering department of the company, and subsequently to that in 1923, as gas salesman in developing new uses in the use of carbon dioxide gas, and in 1926 was made gas sales manager of the company.

[fol. 197] Q. What is the business of the Liquid Carbonic Company, and what is its extent?

A. We are manufacturers of liquefied carbon dioxide gas, which is manufactured in 19 gas plants scattered throughout the United States.

Q. What, approximately, has been the production of CO_2 sold as liquid in the United States annually since 1920?

A. I would say that the annual consumption of liquefied carbon dioxide in the United States is in the neighborhood of fifty-eight to sixty million pounds of gas a year.

Q. What were the uses of carbon dioxide as they were known to you in and around 1920?

A. The principal use, of course was the carbonation of beverages, ginger ales. I would say probably the second

largest use from the standpoint of consumption was the use of carbon dioxide gas in the operation of refrigeration machinery.

Q. How do you sell the carbon dioxide for the uses you mentioned?

A. In steel cylinders which are approved by the Interstate Commerce Commission, designed to withstand 3,000 pounds per square inch test pressure. That is a factor of safety controlled by the Bureau of Explosives. That is because the liquid in the containers is required to be compressed at such high pressures.

There are two usual sizes of the carbon dioxide cylinders. One the so-called 50-pound container, which is designed to contain 50 pounds of the product, and the other the 20-pound container. The 50-pound cylinder has a tare weight of 110 pounds, and the 20-pound cylinder has a tare weight of about 65 pounds. That is, these weigh filled, respectively, 160 pounds and 85 pounds.

[fol. 198] Q. You have spoken of refrigeration machinery. You mean a closed system using compressor and expansion coils?

A. That is what I had reference to.

Q. In such a closed system is solid carbon dioxide formed or utilized?

A. No, the object of that system is to operate between the liquid and the gaseous phases; I should say if any solid carbon dioxide was formed in one of these machines they have in picture houses, which are carbonic machines, it would affect the efficient operation of the machines, causing a clogging in the lines. Our company has participated in the manufacture of solid carbon dioxide for the Dry Ice Corporation.

Q. When did you first begin such manufacture for the Dry Ice Corporation or its predecessor corporations?

A. We first manufactured or delivered liquid carbon dioxide to the Prest Air Corporation, the predecessor corporation, I think around September, 1923, with the understanding it was to be used by them as raw material in the manufacture of solid carbon dioxide, and since that time, with a small interim period in 1925, have constantly supplied the Prest Air Corporation, and subsequently the Dry Ice Corporation, with this raw material. We had originally

sold to the Prest Air Corporation some gas in cylinders, as early as January, 1923.

Q. About how much have you delivered to the Dry Ice Corporation or its predecessor corporations?

A. Over this period we probably delivered in the neigh-
[fol. 199] borhood of 1,000 tons of raw material. As delivered, I mean it has sold as solid carbon dioxide.

Q. Prior to the time when you first came in contact with the Prest Air Corporation or the Dry Ice Corporation, what was your knowledge with regard to the use of solid carbon dioxide?

A. Very little. I had heard of its being used in the so-called snow pencil, used in a skin proposition, and also heard of it being used in the calibration of low temperature thermometers in a small way.

Q. That is, the snow pencil matter you speak of is in connection with the medical use?

A. Yes, sir.

Q. And the calibration of thermometers was where the thermometer was immersed in the solid carbon dioxide so as to get the low temperature reading?

A. That is right, yes.

Q. How did your company come to undertake the manufacture of solid carbon dioxide for the trade?

A. As stated, we supplied them or their predecessor corporation with some of the gas in cylinders, and in due course, about 1923, their officials approached us with the idea of supplying large quantities of our product, which gave us the idea they were going into an expansion of their field. We investigated the proposition from that standpoint, because from our standpoint, if we had excess capacity in our plant, we would be delighted to sell the gas, but there was a doubt in our minds, and the engineers' minds, as to the economy feasibility of it, and as it involved the outlay of much money on our part to change our plant, we
[fol. 200] handled the matter in a conservative way from the outset. Most of the engineers of our plant were of the opinion in 1923 there was a fair possibility this material could not possibly be used practically, or on an economic basis, as it had been described to us.

Prior to the time we began selling solid carbon dioxide to the Dry Ice Corporation or its predecessors, we had no in-

quiries for solid carbon dioxide.

Q. Since you began selling solid carbon dioxide to the Dry Ice Corporation have you had any inquiries for solid carbon dioxide?

A. It takes up a lot of my time writing about it.

Q. At approximately what retail price do you sell liquid carbon dioxide in cylinders?

A. Our retail price probably all over the United States averages about 20 cents a pound. It makes a lot of ginger ale these days.

In the production of solid carbon dioxide at our plant the gas that is not converted into solid, would normally escape and be a total loss unless provision was made to recapture it and in turn compress it to a liquefied stage again, and have a closed circuit. That is what we do at our plant. And we actually sell the Dry Ice Corporation only that part of the liquid that is actually converted into solid.

Cross-examination.

By Mr. Darby:

I have been with this company since June, 1920. We sell the liquid carbonic acid in steel cylinders, either 50-pound [fol. 201] container or 20-pound. In 1920 the price of a 50-pound container of liquid carbonic acid varied with where we sold it and to whom we sold it. Over the United States probably it would be in the neighborhood of 9 cents a pound. That is the wholesale price. The retail price was around 20 cents a pound. In 1923, the price both wholesale and retail I would say the average was probably around the same.

Q. There has not been any reduction in price?

A. In some parts of the country only.

Q. Here in the East?

A. There was a reduction here I think in 1923 on the wholesale price. Approximately from 9 cents to 7 cents, and in the retail price I think probably from 20 to 16 cents a pound, or 15. The price today in New York City, is 16 cents a pound for retail, 8½ wholesale. It has gone up from 1923.

Redirect examination.

By Mr. Kerr:

Q. With one of these containers approximately what percentage of solid could be recovered, I am talking about your standard shipping containers?

A. Within my knowledge I would say about 25 per cent.

Q. So if a person bought a 50-pound container they would get 12½ pounds of snow?

A. I have seen that done. I doubt it would be any higher than that.

(Witness excused.)

[fol. 202] CHARLES L. JONES, called as a witness on behalf of the plaintiff, in rebuttal, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

I reside in Pittsburgh, Pennsylvania.

Q. Please tell what your training and experience have been and what your present occupation is.

A. Following graduation from Allegheny College I attended the Graduate School of the University of Pittsburgh, obtaining the degree of M. S. and Ph. D., and spent five years at the Mellon Institute of Industrial Research on a variety of chemical problems, principally concerned with petroleum and carbon dioxide. Since that time I have been engaged in consulting chemical engineering work, principally in connection with the application of liquefied carbon dioxide. While at the Mellon Institute I did particular work in connection with carbon dioxide. From 1922 to 1924 I was employed by the Carbon Dioxide Division of the Compressed Gas Manufacturers Association, comprising the greater part of the carbon dioxide manufacturing industry in the United States. The particular purpose of the investigation was to find and develop new uses, and to increase and promote old uses for carbon dioxide, in order

to find an outlet for excess manufacturing capacity, that was then available.

Q. Were you familiar at that time with the Osborne proposal, to which Mr. Starr has referred, and if so, state in what way?

[fol. 203] A. I was familiar with the Osborne proposal at that time, and I was personally acquainted with the son of a Chicagoan who was concerned in the Osborne experiments, and still am so acquainted, and he told me some detail of the proposition in 1923.

I was familiar with the earlier experiments in freezing human and animal tissues at that time. You will find mention of these uses of carbon dioxide in my published writings of 1923.

Q. Were you familiar with the properties of solid carbon dioxide, and if so, in what way did you use this knowledge?

A. I was. You will understand that this investigation was not of a general nature. It was not designed to cover the entire field of refrigeration. I was commissioned to spend my entire time on the specific art of the application of carbon dioxide. In this connection the first thing I did was to search the literature, and prepared a bibliography, which at that time, and so far as I know yet, is the most comprehensive bibliography on carbon dioxide listed by the National Research Council. I was subsequently chosen by the American Chemical Society to act as co-author on their monograph on carbon dioxide. I then spent considerable time in developing the application of liquefied carbon dioxide to fire extinguishers, which involved studying the discharge of the liquid, and the formation of solid. As early as 1923 I was associated with the installation of fire extinguisher systems which would introduce as much as one ton of carbon dioxide snow into the hold of a vessel within two minutes' time.

[fol. 204] Q. Will you please state the values of the physical constants of solid carbon dioxide that are commonly accepted by scientists as being authoritative and scientifically correct, citing the authorities from whom you obtain these values?

A. I will, and if I may be permitted to preface my remarks in that respect, there is no mystery about any of

these properties, and I know of no reason to suppose that they will be much more accurately determined than they have already been determined, and all were readily available in chemical literature as early as 1923. The temperature of evaporation at atmospheric pressure, the best value is –109.3 Fahrenheit; the commercial specific gravity of the solid article is approximately 1.1. The specific beats are .284 for the solid, .490 for the liquid, .2 for the gas, all according to Maass & Barnes, in the Proceedings of the Royal Society, Volume 111. The heat values as given are 81.54 B. t. u. per pound, that is, the heat of fusion from solid to liquid at the triple point. The heat of sublimation is 246.4; the heat of evaporation from liquid to gas at triple point is 158.6 B. t. u. per pound. The sensible heat of the gas warming up from –110 to 32 degrees Fahrenheit is approximately 28 B. t. u.'s per pound. The freezing point is approximately –70 degrees Fahrenheit at 60.5 pounds gauge pressure. The volume of gas evolved per pound of solid carbon dioxide is approximately 8 cubic feet. From another reference as early as 1900 the value is given for the heat of sublimation as 283 B. t. u. per pound.

I consider it unnecessary to do more than make that a [fol. 205] matter of record in so far as the values in the fifth decimal place are not of much interest in this connection.

Q. How many times the volume of the solid carbon dioxide is generated as gas when solid carbon dioxide sublimately.

A. One volume of solid carbon dioxide as a commercial article will evolve approximately 500 volumes of gas.

Q. About what is the temperature of the carbon dioxide gas as it sublimes?

A. That has already been given, –110 degrees, approximately.

Q. During this time when you were acting as research fellow for the Carbon Dioxide Division of the Compressed Gas Manufacturers' Association, from 1922 to 1924, did you consider the possibility of using solid carbon dioxide for the transportation of foods?

A. I did. The fire Extinguisher Investigation led to developments of principles of discharge that seemed to be

well suited to the continuous production of carbon dioxide snow. I accordingly recorded a tentative flow sheet and plan for manufacturing solid carbon dioxide in 1923, and attempted to interest the manufacturers of liquefied carbon dioxide at that time in the possibilities of manufacturing the solid on a large scale, but I was unable to do so.

Q. What, if anything, did you do about interesting the Compressed Gas Manufacturers in the manufacture of solid carbon dioxide?

A. I discussed the matter directly in meetings of the Research Committee of the Compressed Gas Manufacturers [fol. 206] Association, including the representatives of about half a dozen manufacturers who operate over 75 per cent. of the carbon dioxide plants in the country, and attempted to sell them the idea that solid carbon dioxide might be manufactured cheaply enough to have some commercial application, but was unsuccessful in convincing them of this.

Q. Why were you unsuccessful in interesting them in the situation?

A. Because I was familiar from study and experience with solid carbon dioxide, with the fact that the heat absorbing capacity of a pound of solid carbon dioxide is less than twice the heat absorbing capacity of a pound of ice, the values stated in the literature is between 275 and 285 B. t. u.'s, as compared with 144 for ice—some values given are considerably lower than that, I know of none higher, I regard the low ones as being definitely in error.

On this basis, taking into account the fact that with this ratio there would be a saving of 50 per cent. in the weight of the refrigerant, and only 50 per cent., and the collateral advantages that are more or less obvious to any person, the dryness of the solid carbon dioxide as compared to water ice, and basing my opinions on the ratio of 2 pounds of water ice to one pound of solid carbon dioxide, I concluded that it was necessary to manufacture solid carbon dioxide to sell for $40 a ton, and certainly not very much more, in order to compete with water ice, which could be had at retail at $12 per ton, and very much cheaper under some special conditions.

The technical representatives mentioned, and in fact every other person to whom I talked, prior to the work of

[fol. 207] the Dry Ice Corporation, including persons supposed to be authorities on refrigeration, all concurred in comparing refrigerants on the basis of their B. t. u., heat-absorbing capacity, and nothing else. The upshot of the discussion was that none of the CO_2 manufacturers were convinced solid CO_2 could be sold for $40 a ton, therefore it was not an attractive commercial proposition. None of us at that time had any conception that it was possible to so use the product as to get any very different proportion or to obtain a sufficiently higher refrigerating value from it in order to justify any higher price.

Q. At the end of our yesterday's session you were discussing the proposition that the members of the Association, that is the Carbon Dioxide Manufacturers, were not interested in manufacturing solid CO_2 commercially as you had suggested to them, and that they had assumed that one pound of solid carbon dioxide could only do the work of two pounds of water ice. Was that commonly accepted in the art, that assumption?

A. It was. It was common practice to compare refrigerants on the basis of their heat-absorbing capacities primarily.

Q. Was that assumption correct?

A. It was not correct.

Q. When did you discover that it was not correct?

A. I was told that it was not correct in April or May of 1925, when I was told that the Prest Air Corporation had shipped fish in Canada using, I think, about one pound of [fol. 208] solid carbon dioxide to replace 10 or 12 pounds of ice in their special manner of using it. I did not believe it. I told my colleagues that it was a physical impossibility, and on that occasion, and on a number of subsequent occasions, I advised several people who asked for advice in the matter of investing money to have nothing to do with it, because it defied all the laws of nature, and in the words of a Professor of Physics in a Canadian university, "It seemed fishy in more ways than one." It was considerable time after that before I was brought to concede what I now know to be a fact, that what you might call higher ice ratios, if you understand what I mean by that term, were really obtained in practice. By ice ratio, I think that is a simple word to use to designate commercial value, that is

hours per pound, or pounds per hour, any way you want to compare them.

Q. Prior to this time when you discovered there was a higher ice ratio, for what purposes had solid carbon dioxide been used?

A. Its actual commercial use was entirely for obtaining extremely low temperatures, which could not be obtained with ice, and in which it was therefore not a substitute for ice in any sense of the word. There had also been a number of sporadic attempts to substitute it for ice in commercial refrigeration, but so far as I am aware, all these attempts failed prior to the Dry Ice Corporation, primarily because the selection of conditions did not give an ice ratio greater than two to one, or appreciably greater.

[fol. 209] Q. What is the refrigerating value of solid CO_2 when used in place of water ice in a water ice structure?

A. It may be most anything, depending on how it is used, but I know of no case where it is appreciably greater than two to one. I think Mr. Starr's experimental evidence checks that very nicely. He obtained almost exactly two to one in his household refrigerator experiment to which he testified.

Q. In the ordinary household refrigerator how would the substitution of solid carbon dioxide instead of water ice work out?

A. As I have just stated, so far as the economy of the proposition is concerned, it works out about two to one ice ratio. As regards the mechanism of the action, which I take it is what you are interested in, it has a number of effects there that are of interest, but do not here appreciably increase its efficiency beyond what any person skilled in the art would expect on the basis of its heat absorbing qualities. It evolves gas the same as it does under any other conditions. This gas tends to fill the refrigerator, and in the ordinary ice box, whenever the doors are opened, the gas, due to its greater weight, tends to pour out the front of the box. I think that you might go on at great length to discuss the details of it, but it is summed up in the statement that this combination of the conditions, the placing of the ice, insulation, the box it is in, everything

else all put together, gives you an ice ratio of two to one.

When you open the doors and the gas flows out because of its weight, it is replaced with warm air which flows in at the top.

[fol. 210] Q. Do you know whether solid carbon dioxide may be or was used so as to give a higher refrigerating value than the ice ratio you have mentioned?

A. Yes, I do.

Q. In what connection?

A. In connection with the commercial packages as shipped by the customers of the Dry Ice Corporation of America.

Q. You have spoken about hearing of the shipment of fish by the Prest Air Corporation. I ask you again to state the date as to when you heard that.

A. That was in April or May of 1924.

I do not know of any person, or any instance, prior to hearing about this work by the Dry Ice Corporation, who used solid carbon dioxide for refrigerating a transportation package in such a way as to do the work of more than twice its own weight of water ice.

Q. Is there an actual and important difference between the factors involved in practical commercial refrigeration with water ice and those involved in refrigerating with solid carbon dioxide?

A. I should say absolutely yes. There cannot be any question about that. The simplest illustration was given here yesterday in the case of a block of ice dropped in a glass of water as compared to a block of solid carbon dioxide. The two behaved in an entirely different manner. They make refrigeration available in a different manner. You do not get the same rate of refrigeration, or same behavior, in any sense of the term. The mere fact that solid carbon dioxide has a low temperature does not begin to sum it up, because there are half a dozen other effects pres-

[fol. 211] ent which I think should be clearly stated. Many are not yet understood as far as the scientific phenomena involved in relation to the different factors are concerned; in other words, a commercial result has been obtained, and it is partially understood, but complete study of the exact value of all the different factors that enter into it still has not been made.

Q. What is the difference between commercial refrigeration with water ice and that involved in refrigerating with solid carbon dioxide, as exemplified, for instance, in the Marchiony shipping case, Plaintiff's Exhibit 11?

A. As the solid evaporates, the gas traveling outward through the package imparts its sensible heat to the more distant portions, and in that way has the effect of cooling the more distant portions, which in this case, of course, are the corners of the package, to a greater degree than could be done by conduction of heat alone, even at the same temperature gradient. The gas as it travels outward forms a bath, as has been brought out, among the packages, as well as around them, which impedes the flow of heat from the surroundings on account of the low conductivity of the carbon dioxide. However, as it forces its way outward it does purge and force ahead of it, not only warm air, but also moisture and heat, in so far as it escapes to the atmosphere at the temperature of the outside of the package instead of at the temperature of the refrigerant. In describing it I should say there is nothing to me personally that is at all remarkable in any one of these things, and [fol. 212] the merit of the finished package lies in combining the three elements, the product and the package and the refrigerant, in such a way as to take advantage of these properties, which we are all familiar with, and to permit them to show up in the cost sheet as giving a higher ice ratio than had been anticipated. I might say, if all the factors were there and failed to produce an ice ratio any higher than two to one, I would say it might be very interesting, but it certainly would not be commercial.

By the Court:

Q. Every one of these properties of CO_2 was known before 1924, wasn't it?

A. Yes, each individual property was known prior to the time when the plaintiff combined them and obtained this result.

Q. How could they have had any different result? Given the package, how could they get a different result?

A. Do you want my opinion on that matter in a straightforward way?

Q. Yes, given the package which is here presented, how could they get any different result?

A. You could not get a different result. Given a steam boiler that has efficiency for burning coal in it a certain way, you get a result, but given a steam boiler that has efficiency of 50 per cent. of the expected consumption of coal——

Q. Then, it would be a bad boiler, and good coal—if the coal was just the same as the coal you had used in the 100 per cent boiler, but you could get only 50 per cent from it [fol. 213] in another boiler——

A. I said 50 per cent. of the expected consumption of coal.

Q. If you had 50 per cent. of the efficiency it would be a bad boiler?

A. Yes, sir. It would not have anything to do with the coal.

Q. And CO_2 is just as good or just as bad, but it depends on the package, on the container?

A. The container in itself does not mean a thing. You cannot substitute water ice in that structure and get results.

Q. We are not talking of water ice. We are talking of the properties of CO_2.

A. The result certainly requires the combination of every element. If you surround, for example, your cake of solid carbon dioxide in a metal sheath and conduct the gas away to the outside atmosphere, although you have the same package, still the whole result drops by the board.

Q. Without CO_2 you would not have any refrigeration, any more than you would have in the ordinary household refrigerator if you did not introduce ice. I understand that.

A. No.

Q. You would not have refrigeration without CO_2 in the package?

A. There are lots of refrigerants.

Q. In this particular package without the introduction of CO_2 you would not have refrigeration?

A. If you did not put a refrigerant in it, no.

Q. I am not talking about that. We are talking about CO_2.

The Court: All right.

[fol. 214] By Mr. Kerr:

Q. Mr. Starr has testified in effect that as carbon dioxide changes from a solid into a gas it inherently forms a surrounding and insulating layer of gas. What is the effect of this layer of gas, as, for instance, where solid carbon dioxide is used in place of water ice?

A. I would say the effect of that blanket is entirely dependent on the manner in which it is used. It is only inherent to the extent of a thickness of a few thousandths of an inch, that is all the blanket there is, unless you provide it with something to enclose that blanket. Again, when you put a block of ice on one side of the household refrigerator the gas blanket is inherent already as far as the particles of CO_2 are concerned, but not inherent as far as surrounding the food is concerned, or traveling in a definite direction. It is entirely a question of how it is used.

Q. We have had on previous days a piece of solid carbon dioxide exhibited on the table with a coating over it. What is this coating, and what does it come from, and what is its effect?

A. The coating is another specific thing to be taken into account. It is formed by the condensation of moisture from the atmosphere, builds up to considerable thickness, and then sloughs off. It builds up in a very soft, fluffy, porous form, which causes a gradually increasing amount of insulation to be built up, and then when it falls away the cake is exposed for a while, which gives increased evaporation, which gives a surging rate of refrigeration. This [fol. 215] cannot be entirely eliminated, because the temperature is so low that any water vapor in the environment will find its way to that intensely cold spot and condense, but it can be controlled by controlling the degree of enclosure, and the degree of accessibility of moisture from the outside air, so as to get a more definite controlled effect from it.

By the Court:

Q. That is the purpose of wrapping it in paper?

A. Yes, sir, it is, although I have performed some experiments in which I have wrapped solid carbon dioxide in several thicknesses of paper, and from those and from gen-

eral observation it really is surprising the degree to which moisture will find that intense cold, traveling, as you might say, upstream against a current of moving gas, and assuming a condition like salmon climbing a stream.

By Mr. Kerr:

Q. I hand you herewith an article by J. C. Goosmann, which is offered in evidence as Exhibit 21, from "Ice and Refrigeration," of May 26th. Would you say that the statements contained in this article in regard to the use of solid carbon dioxide as a commercial refrigerant were well founded?

A. That is an embarrassing question to answer, because I think I would have concurred in a large portion of that article until after the Dry Ice Corporation had made their [fol. 216] packages and gotten their results, and came back and showed it was true. The article, I would say, is not favorable to dry ice. It is headed "Dry Ice." It says in part:

"However, all other claims as to enormous refrigerating properties, duration of refrigerating effect and unlimited usefulness must be put down merely as the bombastic statements of over enthusiastic promoters."

All I can say is that was once the way I felt about it myself, and while the values given here are inaccurate and not in accord with the literature, the weight comparison is entirely on the basis of B. t. u. refrigerating effect, available comparison to money spent. There is no other basis indicated in the article, and I had no other basis in mind prior to the time I indicated.

Q. You have stated one volume of solid carbon dioxide will generate 500 volumes of carbon dioxide gas. Has this any importance?

A. Yes, it has. It means that in designing a specific package for a specific job, the proportioning of the insulation, and the design, are the principles on which the packages work, and how the elements are combined, are extremely important in determining how much purging effect you are actually going to be able to get out of your block of ice. Specifically, the structure that is closely

packed with comparatively solid articles, having a small percentage of voids, is obviously going to purge pretty [fol. 217] frequently. In the case of this Marchiony shipping case the amount of voids left in the package is so small the package replaces its atmosphere every four or five minutes, depending on the surrounding temperature and other factors involved. If it had 90 per cent. of voids instead of 10 per cent., that would be different, and finally you would get to a condition where the amount of voids would be increased, where you would no longer have an outward flow of gas, but have local convection currents as you have in the household refrigerator that circulate, and do not travel outside to the atmosphere, and also some would circulate within the package and return to the cold source, speeding up the rate of evaporation and making it less possible to get efficiencies that make it possible to make the thing commercial at all.

Q. If you have not stated all of the advantages of plaintiff's packages as illustrated in Plaintiff's Exhibits 11 and 12, will you please do so, such advantages as occur to you?

A. Since you ask me that, as a matter of fact I might say from my point of view it has been one of a continually expanding explanation of a result that has already been obtained, that is all. In short, I feel somewhat ashamed myself of not having invented this thing before the inventor did, because I ought to frankly admit in the light of the disclosure and after results have been obtained, that it sounds awfully simple. Another advantage is, in the Marchiony packages, the packages act as thermostats, which actually does take place; that is, when an increase in [fol. 218] the outside temperature takes place the ice cream gets warmer, transports more heat to the solid carbon dioxide, and it thereby increases the rate of evaporation which travels outward again against the flow of heat, and by other effects described, insulation, purging, it tends to dam up the very source of heat that caused it, so that less heat actually enters the packages when more heat attemp-s to enter.

Mr. Kerr: Direct Examination closed.

Cross-examination.

By Mr. Darby:

Q. Dr. Jones, when were you graduated from the University of Pittsburg?

A. I got my Master of Science degree in 1920, and Doctor of Philosophy degree in 1923.

Q. How old were you when you received your Doctor of Philosophy degree?

A. I was an infant in arms figuratively speaking; 25 years of age.

Q. That makes you 30 years of age now?

A. Yes, sir, it does. If there is no objection to the statement, I might say this is a new art, and there are not very many old men skilled in aviation.

Q. I think I understood you to testify that a very important factor in designing a package for transportation employing carbon dioxide ice as a refrigerant was the amount of gas that is evaporated from the ice, is that correct,—did you testify to that?

A. I did not. I did not employ the use of the words "very important" in regard to one factor, and I think I [fol. 219] stressed the fact all factors had to be combined to get a result.

Q. What I am trying to get, irrespective of whether it is very important or not, is what are the important factors. I want an enumeration of the factors. I understand degree of voids was one of them.

A. If you like, we will tabulate that then. One (1) is the frequency of purging——

Q. You said frequency of purging. Will you give me under that as a sub-heading the different factors which determine the frequency of purging?

A. Rate of evaporation——

Q. What is that dependent on, the dimensions of the ice?

A. Dependent, first of all, on time, whether you start with a cold product or a warm one; the relative quantity of refrigerant and product refrigerated; the insulation on the external package.

Q. By that you mean size of insulation as well as thickness?

A. I said the relative quantity of refrigerant and article refrigerated; the insulation on the external package.

Q. You mean on the container itself?

A. Yes.

Q. By that you mean the thickness of the insulation?

A. I can particularize if you wish, but the subject of insulation is so broad I would prefer to let it go with the statement "amount of insulation."

Q. I prefer you to go further, if you do not mind.

A. It might be a thin wall vacuum container, it might be a heavy wall but poor insulator, such as sawdust; it might be a wall of Balsa wood or cardboard.

[fol. 220] Q. Would the insulation around the solid carbon dioxide have any bearing on this frequency of purging?

A. That is the next number on your outline. As a matter of fact, if you will pardon the confusion, I would like to have this outline repeated so far as it has gone.

(The reporter read back as follows: "A. If you like we will tabulate that then. One is the frequency of purging. Q. You said frequency of purging. Will you give me under that as a sub-heading the different factors which determine the frequency of purging? A. Rate of evaporation.")

A. (Continuing:) Rate of evaporation. Under that we had the factors controlling the rate of evaporation as 1, the relative quantity of refrigerant and product refrigerated.

2. The initial condition, and the time.
3. The insulation surrounding the outer package.
4. The insulation surrounding the solid carbon dioxide.
5. The heat transferred to the outside of the package.

Do you wish to split that up further, into radiation, wind velocity, outside temperature?

Q. No. I want the factors which are necessary to a proper design of the package itself. Have you covered them all?

A. No. 6 is the dimensional relation of the most remote part of the refrigerated product to the solid carbon dioxide [fol. 221] itself, as affected by all the other factors, in order to insure that that most remote portion will not be above the maximum allowable temperature, taking into account the fact that this dimensional relation is a different

one for different refrigerants, and that the specific properties of carbon dioxide make it possible to assign values to this proportion that could not be obtained with an equally cold refrigerant of other character, or by a refrigerant of the same character, and not equally cold.

Q. Have you covered all of these factors now that are necessary to be known in order to produce this package?

A. My answer to that is that I would not attempt to write a book on solid carbon dioxide refrigeration.

Q. I am not asking you to. I ask you if you covered all the factors you had in mind when you made that statement in your testimony?

A. I have not covered all of the effects which take place in the practical package.

Q. Will you listen to my question, please, and then answer that? Have you enumerated all of the factors that must be known in order to be able to design the package?

A. I should say that like a great many things that are done——

Mr. Darby: May. I ask for a direct answer to that question?

The Court: Are there any other factors you have in mind?

The Witness: Is it necessary to give a yes or no answer to a question of that kind?

[fol. 222] Q. I did not ask you to do that.

A. My answer would be a knowledge of those factors would be sufficient to design an efficient package, but an efficient package could be constructed without a knowledge of any of them.

Q. As I understand your testimony, and correct me if I am wrong, I understood you to testify unless the package was designed with the knowledge of these factors, and a proper proportioning necessary because of these factors, it would be impossible to produce a commercial structure; was that your testimony?

A. I cannot say. The record will show.

Q. What is your testimony now in answer to that question, as to whether or not my statement is correct?

A. I think the package must be such a package, but I would take issue on the question of knowledge. I do not grant that knowledge is really very essential.

Direct examination.

By the Court:

Q. A man might stumble on it if he stumbled properly?
A. That is the point.

By Mr. Darby:

Q. But to reach that result he would have to design his package to take care of those factors, to produce, intentionally, as distinguished from accidentally, a commercial package. Will you agree to that?
A. Yes, sir, I will.

Mr. Darby: All right, that is all.

(Witness excused.)

[fol. 223] HOWARD S. MCILVAIN, called as a witness on behalf of the plaintiff, in rebuttal, being duly sworn, testified as follows:

By Mr. Kerr:

I reside at 235 Joralemon Street, Belleville, New Jersey. I am a mechanical engineer employed by the Dry Ice Corporation to work out commercial applications of its product. I was employed by the Dry Ice Corporation in March, 1925.

Q. I call your attention to the Balsa Wood box, Plaintiff's Exhibit 10, which you have seen, and ask you to state whether it is practical to use such a box in the refrigeration of ice cream with water ice and salt as a transportation package?
A. It is not practical. It has been tried and was found to be not successful. As a transportation package with the ice and salt mixture in a pan placed in the upper portion of the package it failed to keep the ice cream in a satisfactory condition for a proper shipping period. Furthermore, the covered box covered the ice and salt compartment, and permitted the box to be tilted and the ice and salt spilled over the contents of the box.

The Court: It is quite obvious you had no method of disposing of the water.

Q. How is brick ice cream shipped commercially?

A. In a standard wooden ice cream tube with the ice [fol. 224] cream in covered metal cans surrounded with a mixture of ice and salt.

Q. So far as you know is there any package at all like Plaintiff's Exhibit 10, this Balsa wood box, in commercial use with water ice and salt used as the refrigerant, the package being used for transportation?

Mr. Darby: I object to this line of examination. It has no bearing on this case. It is irrelevant. I have hesitated to object.

The Court: I do not know what you are trying to show unless you are trying to prove the obvious. Even if we sit here we have not lost all hold on human affairs. I suppose most everybody has seen an ice cream tub. I suppose everybody imagines there must be a way of getting rid of the water. In the large tubs they have a hole and plug and they pull it out to let the water out. In the small ones they do not need that, but as we look at that exhibit I did not think anyone was going to contend that you might put water and ice in that, and in that way accomplish any real purpose. I did not know you charged them with having infringed your peculiar package or container. I thought you were trying to hold them as contributory infringers.

Mr. Kerr: We are.

The Court: Because they provided the refrigerant and suggested somebody might use that kind of package, the [fol. 225] same as the ice man furnishes you with ice and would advise you had better have a refrigerator, unless you wrapped it in a blanket and put it in the sink.

Mr. Kerr: No; knowing the refrigerator we used, they brought the ice to Marchony and said it would work perfectly well in that package.

The Court: I suppose somebody might invent a new lubricating grease or oil and suggest to users of automobiles they might use it in an automobile.

Mr. Kerr: But I think that is quite different from this case.

The Court: The automobile, however, could not operate without lubrication, not for any length of time. The bearings would become heated.

Mr. Kerr: If that automobile had to have a peculiar kind of lubrication, that would be a different matter.

The Court: All right, go ahead.

Q. What percentage of the sales of the solid carbon dioxide sold by the plaintiff are used in transportation packages in the ice cream trade?

A. Approximately I should say 90 per cent.

Q. You have spoken of the ordinary ice cream tub, using ordinary ice and salt refrigeration. Have you determined the ratios between solid carbon dioxide and water ice consumed in refrigerating a can of ice cream in a commercial shipping package?

A. You mean to compare the consumption of solid carbon [fol. 226] dioxide in this Marchiony package with the consumption of water ice and salt in an ice cream tub?

The Court: That is only one branch, isn't it? He wants to have them compare it. There are other elements besides that, aren't there, that enter into comparison?

The Witness: I can compare directly in an ice cream tub, if you like.

Q. Suppose you make your comparison, if you have made such a comparison, of using water ice and again solid carbon dioxide in various forms with an ice cream tub.

A. In an ice cream tub using a 5-gallon can of ice cream it takes 70 pounds of ice with a preparation of salt in ratio four to one to carry—may I look at notes?

(The witness refers to notes.)

A. (Continuing:) 70 pounds of ice and 17½ pounds of salt to carry the 5-gallon can of ice cream for 18 hours. In that same tub, with that same can of ice cream, a single piece of dry ice placed on its top, wrapped in one piece of newsprint, 13½ pounds of solid CO_2 carried that same tub 21 hours, which, comparing it on a poundage basis, is .26 hours per pound of water ice, and 1.55 hours per pound for solid CO_2, which ratio is very closely 1 to 6. That, of course, is not an efficient package for solid CO_2, because of the very great excess in space.

I have a diagram which I have prepared showing those matters. This solid black line represents the temperature

[fol. 227] time phase of the ice cream in raising from its initial temperature of .10 degrees Fahrenheit to temperature plus 12 degrees Fahrenheit, which is the temperature at which the ice cream began to soften. The line composed of dots and dashes is the temperature time curve of the can of ice cream with a single solid piece of carbon dioxide wrapped as I have already described. Reducing those to a direct comparison of hours per pound of refrigerating effect, I have shown the ratio .26 to 1.55, which is approximately equal to 1 to 6. The B condition was simply taking carbon dioxide, breaking it up, and using it in exactly the same manner as ice and salt had previously been used; that gave hours per pound .37, which is considerably less than 2 to 1, the ratio which could be expected from solid carbon dioxide.

Q. Why did you use a little more solid carbon dioxide broken up than the amount of ice?

A. Because it required that to fill the same space as the ice and salt had occupied. The ratio is figured on hours per pound, that is a direct comparison of weights.

Mr. Kerr: Your Honor, I would like to offer this in evidence.

(Marked Plaintiff's Exhibit 22 in evidence.)

Q. Can you state how many packages are normally contained in this Balsa wood box when it is shipped, and how much ice?

A. For a 24-hour carry with 50 pints of ice cream, 6 [fol. 228] pounds of solid carbon dioxide are used. For a 48-hour carry with 50 pints of ice cream, 10 to 12 pounds of solid carbon dioxide are used.

Q. What is the weight, if you know, of the water ice in the ordinary shipping tub for a 5-gallon can?

A. 70 pounds. That varies—approximately 70 pounds.

Mr. Kerr: That is all.

Mr. Darby: No cross-examination.

(Witness excused.)

JERRY A. HEDICAN recalled.

Redirect examination.

By Mr. Kerr:

Q. Mr. Hedican, you stated that approximately from September, 1923, to March, 1924, you were associated with Mr. Bright and his associates in the Refrigerator Products enterprise. During that time did you ever meet a man named A. L. Miller?

A. I did not.

Q. You knew of no one of that name associated with that organization?

A. I did not.

Recross-examination.

By Mr. Darby:

Q. Mr. Hedican, you, of course, are being compensated for your time in coming here and testifying for the plain-
[fol. 229] tiff?

A. My expenses. I would not come without them.

Q. No more than actual expenses?

A. Well, no.

Q. Have you agreed on a sum of money you will receive for the time you spend here?

A. I have not.

(Witness excused.)

ELMER H. SCHWARZ, recalled in rebuttal, testified as follows:

Direct examination.

By Mr. Kerr:

Q. The defendant has offered in evidence various prior patents. Will you please take up for discussion very briefly the patents which mention carbon dioxide?

A. The first of these patents which was issued is the British patent No. 13684 of 1891, to Tichborne. I under-

stand this is merely introduced to show the state of the art. Mr. Darby called particular attention to page 2, line 29, which reads as follows:

"The solid CO_2 or snow may be collected into boxes, bags or suitable vessels, provided with non-conducting coatings for its handling or transport,"

and so forth.

[fol. 230] The Tichborne patent is chiefly concerned with an apparatus for manufacturing solid CO_2, and as an incident to the invention, Mr. Tichborne mentions the manner in which the solid CO_2 could be shipped. So far as this last feature is concerned, it would appear it bears no relation whatsoever to a transportable refrigerating package for containing foodstuffs, and recites in no way the manner in which foodstuffs might or could be used in that package. It does not relate to a shipment of foodstuffs whatsoever, and it would be natural to assume that the package is filled up solid with the ice, and there would be no room for any food anyway.

The second patent is the British patent No. 7436 of 1895, to Elworthy. Particular reference was made by Mr. Darby to page 6, lines 22 and what follows. This reads as follows, at least the first part:

"By the use of this solidified gas, all danger from bursting storage vessels is done away with, and also the large amount of freight now paid for the transport of these vessels, the weight of which is from 2½ to 3 times the weight of the liquefied gas with which they are charged. The solidified gas can be carried in simple felt bags, or bags of other non-conducting material. It can also be stored or transported in an ordinary ice box, or in the improved form of ice box now to be described."

[fol. 231] I will refer later to the improved form of ice box which he describes.

This patent also is mainly concerned with an apparatus for manufacturing solid CO_2, and that is shown in the various drawings attached to the patents. As a matter of fact, there are no drawings whatsoever of any refrigerator, and the patent is confined entirely to apparatus for manufacturing the CO_2. I do not think it necessary to go into

details on the apparatus for making CO_2, because that is not involved in this suit, as I understand it. We are concerned with the product, and not its method of manufacture. I might say this, however, that it is very questionable whether even the apparatus for making CO_2, illustrated in the Elwort-y patent, is operative, or at least operative in the way he expects it to work. There appears to be a CO_2 engine or motor, which is marked C_1. You will see that in Fig. 1; and the gas before it goes to the expansion chamber marked f passes through that motor, C_1, through the cylinder, and it is apparent that in expanding in that cylinder if there is any snow that is going to be formed it would be formed there, and there is little likelihood any would be formed in the chamber f, but to my mind that is relatively unimportant so far as the features which Mr. Darby has called attention to are concerned, because there was no trick about making solid CO_2. The whole point I understand being made for this patent is that he merely made the suggestion it might be used in place of ordinary ice. As I [fol. 232] understand it from the figures that have been produced by Mr. McIlvain in his tests, and the testimony of Mr. Goosman, that is not the fact. It cannot be used in the same way that ordinary ice can be used.

Now about this improved form of refrigerator that Mr. Elworthy speaks about, that occurs from line 29 to line 38, I believe, on page 6, and it will be seen that this is in no way related to the invention that is involved in this suit, because it merely states that he improves over ordinary ice boxes by making the walls double or triple, and that they may be of metal or glass, and that they may be secured together so that the joints are air-tight, and that the walls should have as few points of contact as possible. He also suggests that the space between the walls be exhausted to the highest possible vacuum, and in order to protect the box from injury, and to further increase its non-conducting power, the box may be enclosed in an outer case of wood, taper boards, or any other strong non-conducting material, or of metal, and if preferred the space between this outer box and the internal one may be filled with non-conducting material.

He does not illustrate this ice box, and it is proper to assume that it would have the usual doors opening into it, and if that were the case, as soon as those doors would open the

heavy carbon dioxide would leak out through these doors, and, of course, the refrigerating effect which is produced in the structure of the patent in suit is not found in the Elworthy arrangement. There is no statement regarding the [fol. 233] use in such ice boxes, if it could be used efficiently, as to how the CO_2 is to be placed with respect to the refrigerated product, whether it is to be in close proximity or not. As a matter of fact, the refrigerator suggested by Elworthy is not a transportable package, and it is apparently not intended to be used for the transport of ice cream or other freezable products.

Now, there is an interesting statement beginning at line 42 of the same page 6, as follows:

"By placing a small quantity of the solidified gas in a small box preferably made of silver, or aluminum, and which box may also contain ether, or alcohol, and immersing the box in any liquid or solution, the latter may be cooled without contact with the gas, and in this way the delicate boquet of wines, and other liquors, is preserved. The boxes should have an escape tube, which may be of sufficient length, and of such a shape, as to act as a handle."

By the use of ether he gets a very cold mixture, which is in a sort of slush, or liquid form, and that is immersed in a liquid or solution, this whole box. It is not direct refrigeration by solid CO_2 passing through the material. It is a cold metal container which is immersed in the liquid and as a matter of fact he wants to keep the CO_2 from pervading the material which he wishes to refrigerate, whereas in the invention in suit the opposite is the case.

[fol. 234] We come now to Elworthy United States Patent No. 579,866. Mr. Darby called attention to a similar statement to the British patent on page 2, line 130 of the United States patent. I am not going to waste any time on the United States patent, because it is the corresponding United States patent to the British patent, and is even not as complete as the British, so what I said regarding the British patent applies equally to the United States patent.

I will come now to the French patent No. 333,181, to Crepin. I would like to say at the start that this French patent is not a transportable package. It uses CO_2 as a refrigerant in a manner somewhat similar to the ice boxes de-

scribed by Mr. Lavigne, that is, this inventor had the idea of refrigerating not by a solid cake of carbon dioxide put in a refrigerator, or in an ice cream container, but in a structure very similar to the coil pipe closed systems of the present time, that is, where you use the compressor and cooling coil, or expansion coil. He used a coil very similar to the expansion coils of the present mechanical refrigerators, and he hung that near the top of his ice box, and above it was an expansion chamber in which he had the idea snow would be formed, and he also had the idea, as he states, snow would be formed in the coil member after the evaporating gas in this expansion chamber would enter the coil pipes. According to this construction it would, so far as I can see, be impossible to get the results which he expected; I will point this out.

[fol. 235] If we refer to Fig. 1 of this patent we see that there is no solid CO_2 introduced into his refrigerating chamber, a, but he uses a tank of liquid CO_2 inverted, which is indicated by the letter b. There is a throttle valve marked c at the bottom, by which the admission of the liquid CO_2 into the expansion chamber, which is marked f, and shown better in Fig. 2, is controlled. Now, the inventor states that there would be some snow formed in the chamber f. The fact is that he describes the outlet opening m, which will be seen in the bottom, as a capillary, which term your Honor has heard before, meaning a very small opening, and it is shown as a very small opening. Under these circumstances the liquid CO_2 would fill up part of, or the entire, expansion chamber f, and you cannot produce snow by having the liquid in the chamber that way. You have to have the snow formed from the liquid before it enters the chamber, and with that small opening very high pressures would be set up in the expansion chamber. As a matter of fact, the pressure would be in accordance with the amount of liquid that was emptied from the tank b. If the chamber f was the same capacity as the tank b, the pressure would be one-half of the original pressure in the tank b, which is around 1200 pounds for liquid CO_2, so you would have to design that expansion chamber f so as to withstand that enormous pressure, and it is not shown to be so designed, but assuming it is so designed, there would be no snow formed in that chamber according to the structure he

[fol. 236] shows, except possibly at the very beginning of the operation, when momentarily a little snow would be formed before the pressures are increased within the tank. In order to produce snow you have to have a high differential in pressure between the liquid entering the expansion chamber and the pressure within the chamber itself. Now, if we throttle the valve c so as to let a small amount of liquid CO_2 into the chamber f at a time, the gas will begin to expand in the pipe e, and shortly snow would form in the pipe e and clog it up, and that would not be satisfactory. The other contingency is that snow be formed in the coil pipes marked s. If we assume that the chamber f is entirely filled with liquid CO_2 and can stand that pressure, and is filled even down to the point of exit m, which is the capillary, then it is possible to get some snow formed in the coil pipes, but it will be apparent to your Honor that that snow forming in there would soon clog up the pipes, and the system would be stopped up until enough of the snow sublimed to allow more gas to enter the system.

Now that is the disclosure he made, and it is apparent on its face that Crepin did not know exactly how things were going to work, and it has the appearance of a paper patent.

There is another statement in the patent by the inventor which indicates that he really did not know what was going to happen, or did not understand the theory of the operation of liquid CO_2, or gaseous CO_2, because he states in the patent that the gas arising from the evaporation of the [fol. 237] snow in the chamber f will turn into snow in the coil pipes. That is an impossibility in this situation, that CO_2 gas can be converted into snow. It cannot be done in any such arrangement as this. The gas would expand and would not turn into snow. You have to have liquid brought to the point of entry to the expansion chamber before you can get any snow formed.

There is a statement in the patent that the gas coming from the end of the coil pipe fills up the refrigerating chamber a and drives out the air through the valves at the top of the openings o at the top of the refrigerator. If the system would work the way Crepin expected and gas could come through those pipes regularly, that is, continuously, even though they were clogged up, then you might have an atmosphere of CO_2 in the ice box, and he apparently had no

idea that that gas would be effective as an insulating envelope, because he only speaks of the desirability of having gas in order to act as a preservative of the food for which CO_2 gas is well known. He does not show in the drawing any means of getting at the food in the refrigerator. It is to be assumed that it has doors in it, and every time these doors were opened the gas would fall out rapidly. Therefore it is plain to me that it would be most difficult to have that refrigerator with the construction he has shown filled with CO_2 gas at any one time.

As I stated before, it is not a transportable package, it is a stationary refrigerator, in which shelves are used on [fol. 238] which food is placed. It must always have a heavy container of liquid CO_2 attached to it, as shown, either inside or outside, and so far as transportation goes it would be absolutely an impractical arrangement if any comparison is made with the invention in suit. Those gas tanks would only last a short time, as I believe Mr. Hedican stated, and you cannot get away from that.

Now we come to the patent No. 344,957 of 1904. I believe this was introduced merely to show the state of the art, and was not in the original answer. All I have of that is a translation which Mr. Darby furnished.

I believe Mr. Darby referred to the second paragraph of the translation, which reads as follows:

"By the evaporation, the liquid carbonic acid, as is also known, is solidified into a snowy mass, and can be maintained in this form for shipping, without great difficulty, provided care be taken to maintain a sufficient low temperature."

Now that is all this patent relates to, a method of shipping solid CO_2. It will be seen by reading the translation, from the last paragraph of page 1 on, that we have a very complicated structure here made up of pistons and compressors and solid CO_2 brine mixed with ether for surrounding the solid CO_2 with a cooling medium. He says that the receptacle is provided with a double envelope comprising a vacuous space b, and an outer layer c, which is a poor con- [fol. 239] ductor of heat, and which in its turn is lined in an insulating manner. The vacuous space b contains always a refrigerating mixture, preferably of liquid carbonic acid and ether. The evaporation of this refrigerating mixture

placed in the space b insures constant cooling of the contents of the chamber a, where the carbonic acid in solid state is located.

He also says:

"In the evaporation chamber b is provided a small suction and compression apparatus, the piston rod of which, operated from the exterior by any suitable control e, passes through a stuffing box p, which insures tightness."

And he says that said compression apparatus continuously sucks out of the surrounding envelope, that is the one containing the brine, the vapors arising from the mixture of ether and carbonic acid, then it compresses them and returns them in liquid state through the tube m. He says a small motive power is required for this, and a little below that he says:

"There is a forcing pump piston, shown in the drawing by the rod o-n."

I do not think this particular drawing shows that, but maybe it is unnecessary to see the drawing. This is used for evacuating, I suppose, the CO_2 gas coming off from the solid CO_2 in the chamber s. That is the inner chamber. So [fol. 240] we see that the invention relates merely to an apparatus for shipping CO_2 in solid form and it requires the very complicated structure shown in the patent of pistons and compressors and safety valves and quite a few other details, which, so far as I can see, would be impracticable on account of the excessive weight and the complications of the system. It has no relation whatsoever to a refrigerated food package, which is involved in the patent in suit.

The next is the Elworthy British patent No. 2450 of 1906. Mr. Darby referred particularly to page 2, line 25. This reads as follows:

"Having obtained the liquid cooled as above it is then drawn off into the molds above described wherein it is solidified. The molds may be of any required form, but are preferably made with a slight taper, being slightly wider at the top, so as to allow of easy extraction of the solid."

I thought may be it had something to do with shipment of insulated packages.

This patent again, as in the earlier British patent of Elworthy, relates to apparatus for making solid CO_2, and in this case he apparently free-es the liquid CO_2 rather than to make a snow as he did in the original patent. He says:

"Whether the carbon di-oxide be obtained as waste carbonic acid from fermentation or as waste gas from the manufacture of yeast, its recuperation if not operated with a [fol. 241] view to solidifying it, is not practical as the use of liquid carbonic acid is only a very restricted one and needs very expensive devices for storing it up and for transporting it (by means of thick walled closed tubes) which may be avoided by solidification."

And to make this explanation short, I will come to the point which is really the gist of the invention, and that is that this solid CO_2 is made in the following manner:

"The carbon di-oxide having liquefied in the manner above described, the liquid is drawn off into moulds or receptacles, preferably of copper, aluminum or other good heat conducting material, and such moulds or receptacles are enclosed in an insulating tank or box which may be either filled or partly filled with a liquid whose solidifying point is below that of the carbon di-oxides, such as alcohol, and this liquid is cooled to the desired degree by the circulation of cold air or other gas through coils of pipe immersed therein."

That is, the gist of the invention is not to make solid CO_2 snow, but to freeze the liquid below the —110 degrees, or thereabouts, which is the temperature of the snow, and which is the subliming temperature of solid CO_2 under atmospheric conditions.

Now the next patents that I will refer to, for the most [fol. 242] part are set up as anticipations of the patent in suit, and they relate to containers. One or two of these were put in at the time of the trial, and are merely set up to show the state of the art.

The patent No. 533,794, to Drummond, dated February 5, 1895, merely relates to a refrigerator shipping box for shipping ordinary ice. Your articles to be shipped are placed in the inner chamber 7, and the ice itself is to be placed in the outside chambers 8. There seems to be a

space marked 10 and 12—those are cleats, I guess, in Fig. 3. I do not know what kind of a chamber it is at those points, whether the chamber 8 goes around the entire box or not.

Mr. Darby: Line 90, Mr. Schwartz.

A. (Continuing): "Form a lower ice receiving compartment." There is a lower ice receiving compartment shown in Fig. 2, I take it, inside of the cleats 12, but in Fig. 3 there is a compartment at the top of the box marked 10, which may or may not be an ice compartment.

I do not see any reference to it in the description, but at least the food is to be placed in the center, and the ice is put around it. The patent relates specifically, as I take it, to the partitions which are removable between the food compartment and the ice chamber. There is no suggestion of the use of any other refrigerant, at least, of solid CO_2, that I can find in the patent, and I believe it has no bearing on the issues in this case.

[fol. 243] The next patent is No. 236,906, to Mosler & Ladewig, January 25, 1881. This relates to an ice box for butter. The ice is placed in a chamber at the top center of the box, while the butter is placed in drawers on each side and across the bottom. The sides of the drawers are cut away or set low, forming a channel b, so that the refrigerated air has full access to the butter within the drawers. To get at the butter the entire front of the box is opened and the drawers can then be pulled out. The arrangement is similar to that of an ordinary ice box where the ice is placed at the top and the cold air descends therefrom through the food chambers, after which it returns to the ice chamber. It is somewhat doubtful whether the arrows shown in this patent indicate the true course of the air current. As shown, they indicate cold air traveling both to the right and left to the drawers on a level with the ice chamber, and also downwardly to the wide drawer below the ice chamber. Just how the air returns from these drawers back to the ice chamber is not indicated. In my opinion, the true course of the air would be downward from the ice chamber to the wide drawer below it, and thence upward through the smaller drawers on each side of the ice chamber back to the top of the ice chamber.

I do not believe the patent shows the scheme by which this returning air comes up through these wide drawers

and back to the ice chamber. This is not a transportable package, as I take it, and it could not be practically used [fol. 244] for shipping food, and it is for ordinary ice, not apparently for ice and salt, and not to be used for cooling or keeping cold freezable mixtures like ice cream. Of course, the temperature would not be low enough for that if ordinary ice were used. The whole front of the thing has to be taken out in order to get at the drawers, and this would not be a practical construction if any attempt was made to use CO_2 in it.

The next patent is that to Dickerson, No. 256,299. This is merely introduced to show the use of CO_2 gas as a preservative. There is no drawing whatsoever in this patent, and it relates to a process of refrigerating and preserving meat and other articles.

The main object of the invention is the use of CO_2 gas reduced to an abnormally low temperature for the preservation of meat and other articles. It is the use of the gas. There is no suggestion of solid CO_2. In carrying out the invention CO_2 and nitrogen is compressed and expanded by an apparatus like that of another patent mentioned therein, the patent to Coleman, No. 226,281. That is a compression and expansion apparatus, mechanical refrigerator; as an alternative means for producing the cold CO_2 the patentee suggests that natural refrigerants such as ice may be used. In other words, he wants CO_2 gas and then he wants the gas cooled and he says:

"In either method the supply of gas should be provided in an independent chamber which can be used to constantly [fol. 245] maintain the gas within the refrigerating chamber."

Now the next is to Emmens, patent No. 652,759. This relates to refrigerating and refrigerants. This patent describes a method of reducing ice or other liquids to a very low temperature by bringing them in contact with liquid air. This makes them available for refrigerating purposes in the form of portable blocks. The substances which the patentee employs are water, brine, cryohydrates, which I understand are saline solutions of such strength in each particular case as to have a minimum freezing point. I think that may be described as such.—"Alcohols, and mixtures of water with glycerine, or alcohol or

both." In the case of water ice the patentee claims that he obtains a temperature as low as 300 degrees below zero Fahrenheit. The substance which the patentee prefers over all others he calls "glyce", which consists of 50 per cent. of water and 50 per cent. of glycerine. It freezes at about 23 degrees below zero Fahrenheit. By this invention the patentee claims that he is enabled to more than double the cooling power of ice, thereby affecting great economy of weight, bulk and expense.

That patent deals entirely with a refrigerant of the nature which I have described, and its method of manufacture, and has nothing to do with its use whatsoever. There is a statement in there in lines 37 on as follows:

[fol. 246] "In order to conveniently transport and use the said blocks in a preferred way, they are put in cases or jackets of felt lined wood or other partially heat-insulated material, by means of which the cans are protected from injury during transport, and the cooling power of the blocks is regulated as to speed and action, and when such cooling power is exhausted the jacketed cans are returned to the charging station,"

and so forth. Above that it is stated:

"I am thus enabled to prepare portable blocks of material containing various amounts of cold, that is, negative thermal units reckoned from the temperature to which the refrigerants are ultimately to rise when employed for cooling purposes."

There is no suggestion of solid CO_2 in this patent, and as I said before, no refrigerating food package mentioned.

The next patent is that to Rumpel, No. 1,130,932. This patent relates to a receptacle of waterproof material having a central lower ice chamber for keeping refreshments cool. The receptacle is to be thrown away after use. The ice compartment is perforated, and it is understood, and I believe the description so states, that the level of the melting ice must be kept below those perforations so the water won't leak all over the articles inside. The edibles and drinks in bottles are packed around and over the ice [fol. 247] compartment. The products that are supposed to be used in this package, that is, that are to be cooled

are not freezable, and since the temperature in the container is considerably above the freezing point, the articles to be cooled are not in freezing proximity to the refrigerant, of course. The action and the purpose, of course, are entirely different from the package of the patent in suit on account of using ordinary ice here. Of course, there is no envelope of insulating gas in the package. As the ice melts, of course, the air has to take its place, and this warmer air coming in will act in just the opposite manner from the method of the Slate invention, where, if there is any warmer air in the package, it is constantly being scavenged out and carried out by the pressure of the gas within the container.

The next patent is No. 1,133,299, to Lundin. There is no necessity in wasting any time on this patent, because it merely relates to the use of Balsa wood as a high insulating structure in a refrigerator, the construction of the refrigerator not being shown, except that there is a door near the bottom of it.

The next patent is to Cremieu, No. 1,421,176. This is an immersion device containing solid CO_2, the device being in the form of a hollow or cylindrical container 5, at the top of which is a handle 8. This is immersed in any liquid you want to cool, and the cooling action is supposed to be accomplished by the direct physical contact, you might [fol. 248] say, between the CO_2 and the liquid in which it is immersed. This does not seem to have much of an analogy to the Slate invention because there is no such direct contact or immersion of the Slate CO_2 in the article to be refrigerated. You would not think of putting the solid CO_2 in the midst of a body of ice cream, because it would not accomplish the purposes for which it is intended, and it is quite possible that the bubbles of gas from the inside of the ice cream would cause considerable trouble, and displace pieces of ice cream in the container or in the receptacle. I believe that this method of refrigeration is the kind that was condemned by Mr. Goosmann where he said there could not be much refrigerating effect produced in this way, by direct immersion of solid CO_2 in water or other liquid.

The last patent is that to Josephson, No. 1,515,119. Josephson had the idea of using liquid CO_2 in a container, one of these tanks indicated at one end in Fig. 1, bringing

that up near the object to be refrigerated and connecting a pipe from it to an expansion device, cone-shaped, as shown in Figs. 2 and 4. It will be noted that his container is not inverted, that is, the liquid CO_2 container, and on that account you do not get any snow formed in the expansion device shown in Figs. 2 and 4, because, as I said before, you have to bring the liquid right up to the point of expansion, and that this is the case is substantiated by the fact that Josephson mentions nothing about the use of solid CO_2, but merely that he is employing the principles [fol. 249] of expansion of liquid CO_2 to get his cooling effect.

As in the previous patent which I described, this cone-shaped expansion chamber is directly immersed in the liquid, and the illustration appears to be of some container of water, or a glass, for example, or a similar device.

The patent also, I believe, suggests the use of this invention for filling automobile tires with pressure, that is, gas pressure. He uses CO_2 gas instead of the ordinary air.

To sum up, I do not find in any of these patents which I have discussed the combination of the patent in suit, nor do I find that there is anything in these patents which taught the invention of the patent in suit.

Q. Will you please turn back to the Mosler & Ladewig patent No. 236,906? I think you said something about this not being intended for transportation, but I call your attention to lines 36 to 39 in the second column.

A. I was in error. That is true. It says the lid or door of the box a is closed and the butter may then be sent to market or stowed away for use. In that case, if it is sent away to market, there is a separate ice compartment marked in which the ice is placed, and it is closed up so that whatever water is formed is allowed to stay in there until it is dumped out.

Q. The compartment d is then a closed compartment, and the air cannot get out of it, and the water cannot get out of it?

A. That is right. There is no open communication between the ice chamber and the food to be refrigerated.

[fol. 250] Cross-examination.

By Mr. Darby:

Q. Just look at the patent in suit and show me where the carbon dioxide gas gets out in the open atmosphere in that form of transportation package?

A. In that particular package under the lid, and it is so described in the main patent from which this is a division, and also it works out through the pores of the container.

Q. Wouldn't the same be true with respect to the last patent of the prior art you were considering, in which you said there was no possibility of air getting out?

A. I do not know that I said that.

Q. I understood you to say that.

A. I said the Mosler & Ladewig patent does not disclose the method by which the returning air circulates back into the ice chamber or the structure surrounding the ice chamber.

By the Court:

Q. Is that so? If you notice on the right hand side there is an arrow which takes a different direction, may not the arrow above indicate that the cold would travel down, and the arrow below inverted indicate that the returning current would be upward?

A. The criticism is not important.

Q. If you look on the right hand side above c you have an arrow that points downward, in b you have an arrow that points upward. Was that to indicate there would be a downward course and an upward course, or what does it mean?

[fol. 251] A. Frankly, I do not know what it indicates, because this arrow at b that you see might indicate that some air returns, as it would have to, of course, up through the drawer c, but that same air might first have to go down through the drawer b.

Q. Concede-ly so.

A. And this arrow pointing rather downward above c I think must be wrong, because I do not see how it would go down that way.

Q. The cold air would go downward in the first instance?

A. It would go down directly from the chamber d. It is of little importance.

Q. If the side were porous the air would escape through the sides, and it would still have the direction it had originally?

A. The air would be coming in rather than going out all the time.

Q. It does not say here there is an incoming of the hot air and then there is an outgoing of the cold air. If the primary direction of that cold air that escapes would be downward——

A. Yes.

Q. Then it would afterwards return upward, isn't that what the two arrows say?

A. I cannot say. It is very confusing. The way it appeared to me was the inventor had the idea the air would go out from the chamber in all directions. There is very little importance to that.

By Mr. Darby:

Q. So far as it appears in the Mosler patent, the compartment in which the ice is completely closed, is it not, on all sides?

A. That is the way it looks to me. The ice is contained in a little tank d with a lid on it, and when you want to [fol. 252] replace the ice after it is all melted, you simply remove that tank and put more ice in it.

Q. If you substituted solid carbon dioxide for the ice in that tank, the gas would find its way past that lid in exactly the same way as shown in the patent in suit, wouldn't it?

A. The gas would have to find its way out, but instead of air being circulated around, the air would be driven out by the gas. And there would be a tendency to a slight vacuum within the tank as the air cooled off, rather than creation of pressure by the gas itself.

Q. There is no question about that. If I put solid carbon dioxide in that compartment d of that prior art patent, would the carbon dioxide gas get by outside of that compartment d through the interstices between the cover and the container?

A. I think it would blow up if you put——

Q. Why would it blow up in that prior art patent and not in the patent in suit?

A. Because this is a tin container with a solid cap.

Q. What kind of container is described in the patent in suit?

A. An insulated container with a loose wooden cover, or at least the cover is such——

By the Court:

Q. If you let the cap off, then what?

A. Then it would escape out in the atmosphere.

By Mr. Darby:

Q. Or if the cap was not on very tight, the same thing would happen?

A. Yes, sir, but there would be no action like in the [fol. 253] patented container. This is a metal can, and the whole construction would be adverse to such action.

Q. If they made it of wood instead of metal?

A. If you made the whole thing over according to Slate, yes.

Q. Just make the wooden container for the refrigerant, then what?

A. You have a lot of space. This is not packed the way ice cream is. It is not a freezable product. The butter is in drawers and there is a big space between. It is not a practical transportable package as shown.

By the Court:

Q. You do not want the same degree of cold for butter?

A. This is not to keep freezable material.

Q. If you had the metal tank and larger area you would not have as low a degree of cold, would you?

A. Certainly not.

Q. Then it might do for butter?

A. The solid CO_2?

Q. Yes, in this, whereas it would not in the other?

A. I do not think solid CO_2 put in there would be proper for butter in that form.

Q. That is what Mr. Darby wants to know.

A. I think if you get down to such a low temperature nobody would think of cooling butter in that way.

(Witness excused.)

(Adjourned to Monday, March 5, 1928, at 10:30 A. M.)

[fol. 254] Brooklyn, N. Y., March 5, 1928.

Met pursuant to adjournment at 10:30 A. M. present as before.

A. Lewis Miller, called as a witness on behalf of the defendant, being duly sworn, testified as follows:

Direct examination.

By Mr. Darby:

I am in my fifty-eighth year. I reside in Rochester, New York. My occupation is dealing with stocks and bonds and securities. That has been my business.

Q. I hand you this letter which has been marked Defendant's Exhibit I. Are you the A. L. Miller, the addressee of that letter?

A. I am. I received that letter. I placed it in my files with other papers; correspondence. At no time while the letter or envelope was in my possession was either of them altered in any respect.

Q. And then what did you do with the letter and envelope?

A. Just placed it with my papers as I ordinarily placed all papers. I gave those papers to you about six or seven months, probably, ago.

Q. Have they been altered in any respect from the time you received them until you gave them to me?

A. Nothing, except some notation here on the bottom.

Q. The marking of the exhibit by the Clerk of the Court?

A. Yes. Otherwise the letter is identically the same. [fol. 255] The papers have not been altered in any respect from that time so far as you can observe.

Q. Will you please read the letter, and with your recollection refreshed from the reading of the letter can you tell me what year you received the letter?

A. From the date of this letter ordinarily I would say that was absolutely the time it was received, May 23, 1923, as dated. From this first paragraph and in the second paragraph where it says "I saw at the Hup", I did not see anything at the Hup until sometime in the early spring, I would say, of 1924.

Q. Did you ever become associated with the idea of employing solid carbon dioxide as a solid refrigerant?

A. Yes.

Q. Referring to such documents as you may have in your possession to refresh your recollection, will you please tell me when you first became associated with that project, and with whom, and the circumstances relating to it, please?

A. In 1923, in the early spring, a man brought this proposition of using carbon dioxide as a refrigerant for household purposes for an ice box to me.

Q. Solid carbon dioxide, was it?

A. Yes. And it was then in its experimental stages, as I understood, and later in the year, somewhere around April, I went up to Detroit to see this.

Q. What was the name of the man who had the thing that you saw?

A. There was a man by the name of Bright who had brought this to my attention. The man who had worked on this refrigerator was a man by the name of Sorensen.

Q. Did you see the box he had when you made this trip to Detroit?

A. I did.

[fol. 256] Q. Do you recognize this box, Exhibit J, as the Sorensen box?

Mr. Kerr: That is objected to. He has not specified the time he saw it, or asking him to tell the story. He is practically leading the witness with this kind of examination.

The Court: I do not understand that.

By the Court:

Q. Did you ever see this box before? Have you any way of telling?

A. It looks very much like the box I saw that they were experimenting with.

Q. Open it and tell me if you did not see that, if you saw a box like it.

A. Yes, a box similar to that, and there were others with smaller compartments in, a number of boxes; as they explained to me they were the experimental work they had been doing.

By Mr. Darby:

Q. Similar to this box, Exhibit J?

A. Yes, sir.

Q. Have you any documentary records that have been in your possession from that time which have refreshed your recollection so as to enable you to give us the date?

A. Yes. Here is a telegram of June 27, 1923, in which this man Bright says:

"A. L. Miller, 594 Plymouth Street. Have complied with [fol. 257] my contract every thing O. K. ready go ahead appliance now completed too heavy take Rochester Sorensen now working small apparatus for demonstration purposes proposition success beyond question try raise sufficient money to incorporate any preliminary expense you may offer five for one as inducement party putting up this money will make fortune you may bring anyone here to make inspection would like you come any event as I will wait until apparatus is completed Bright."

Q. That is the original telegram you have been reading from?

A. That I received.

Q. And it has been in your possession from that date?

A. Yes, all my papers. After receipt of this telegram I went to a gentleman in Rochester who was the President of the Mayer Paper Coating Machine Company of Rochester, to see if he would be interested in this proposition. Mr. Mayer said he would look it up and that he was going to Chicago within a few days and on his way to or from would stop to see this proposition. On the 30th of June, Mr. Mayer told me that he would go and see this, so I wrote to this man Bright at the Hotel Fort Shelby, Detroit.

"This will introduce to you Mr. Charles W. Mayer of whom I have spoken."

over the telephone, evidently.

"Kindly take Mr. Mayer to see Mr. Sorensen and show [fol. 258] him the whole of the ice proposition. At present writing I do not know if I shall be able to make the later train tonight, but expect to be in Detroit in a few days."

On the 30th I wired Mr. Bright:

"Mayer leaving this afternoon by boat. Call you on 'phone evening."

Mr. Mayer did go and saw Mr. Bright at Detroit on Saturday on the boat, was there on Sunday morning, and as I understand, spent Sunday there.

Q. Did this proposition develop to a point where a home ice box was built?

A. A container for an ice box.

Q. Was any publication made or any mention of it made in the public press?

A. That follows later. There was a publication.

Q. In this article appearing in the Rochester Herald of Sunday, March 9, 1924, the one you referred to?

A. Whatever the date is on there, that is the article.

Q. Did you have anything to do with having this photograph of the ice box taken?

A. Yes. I had this cut made from which this was taken and a bill that I paid for them at that time. This bill was dated April 8, 1924.

Mr. Darby: I offer in evidence the newspaper article referred to by the witness.

Mr. Kerr: We expect to show this whole thing is entirely immaterial and irrelevant, and so we object to the [fol. 259] whole deposition on that account, but I do not specifically object to this.

The Court: We will take it.

(Marked Defendant's Exhibit T in evidence.)

Q. Have you got any personal document with you which would enable you to state definitely the month of 1923 when you were first approached in connection with this solid carbon dioxide ice as a refrigerant?

A. I have for a number of years kept a little private diary, and with this coming up, I have looked at it as various times, and while it does not state exactly the subject matter, it indicates the name of Bright or Sorensen, or Sorensen or Bright, or whatever individual was connected with it.

Q. Can you tell us from refreshing your recollection from that, or any other documents you have, the month of 1923 you first became interested in solid carbon dioxide as a refrigerant?

A. On the 23rd of April, 1923, I left for Detroit and stopped at the Statler Hotel relative to a refrigerator, that is only a memorandum. There is some beyond that, I am sure.

Q. And you are positive that this telegram from Mr. Bright to you of June 27, 1923, that you read into the record, was in connection with this project of solid carbon dioxide as a refrigerant?

A. Oh, yes.

Mr. Darby: May I offer that original telegram in evidence?

(Marked Defendant's Exhibit U in evidence.)

[fol. 260] Mr. Darby: And the telegram from Mr. Bright of July 2, 1923.

(Marked Defendant's Exhibit V in evidence.)

Cross-examination.

By Mr. Kerr:

Q. Am I correct in understanding that you said that the machine you saw at the Hup plant was in March, 1924?

A. Sometime around that time.

Q. And this letter of May 23rd refers to that machine?

A. This letter here refers to the machine——

Q. Which you saw nearly a year later for the first time?

A. No, I saw this in 1924. I saw the machine at the Hup plant in 1924. That is the only machine at the Hup plant that I ever heard of.

Q. So in referring to this machine at the Hup plant, if it was seen by you in 1924 the letter must have been written in May, 1924, is that correct?

A. It would have to be, because it was not until after this company was formed, which some of my documents show was in 1923, the latter part, during the holidays, November and December, somewhere in there, and I did not go on to Detroit until later on in March. At that time they were

making some tests of these various containers at the Hup plant.

Q. So evidently there is a mistake in the date of the letter?

A. There positively must be according to those dates.

Q. Who had this refrigerator unit tested out at the Hup plant in March, 1924?

[fol. 261] A. Presumably by the order of the Refrigerator Products Company.

Q. Who had charge of testing it out?

A. I could not say. At the time when I went up there Mr. Nikerson, who was at that time production manager of the Hup Automobile Company, and who was an officer of the company, was making those tests, as I understood, under his personal supervision. At least, I saw those there at that time with him. He was in charge.

Q. How much stock did you sell of the Refrigerator Products Company?

A. Probably 25,000. It was sold in various places.

Q. What happened to the Refrigerator Products Company?

A. That would be a pretty difficult matter to find out. I have not been able to. The company was formed, and then some trouble developed, internal trouble; I do not know of what nature, it was taken over by some Chicago people, and as near as I can trace it out, the Chicago people made some deal with a new company that was formed, called Refrigerator Products Company.

Q. You don't know that?

A. Just as I have been told, not of my own knowledge.

Q. You say sometime at the end of 1923 the Refrigerator Products Company was formed?

A. I was so informed.

Q. Did you get any of the stock?

A. No. I must qualify that. There was a thousand share certificate and I had 500 shares of that.

My first visit to Detroit in connection with Refrigerator Products Corporation was in March, 1924.

[fol. 262] Q. Who did you meet when you went there? Who was then connected with it and acted in it in March, 1924?

A. Dr. Lathrop, Mr. Nickerson, Mr. Young and Mr. Stelwagon. Mr. Stelwagon was president. At that time they had an entirely different unit from this box that is here in evidence and was shown to me.

Q. And that was the first time you had seen that new box?

A. No. That new unit was brought on, a metal container such as shows in that photograph in the newspaper article, was brought on in February of 1924 to Rochester. That is the first time I saw what was the development of the work that had been done to make this container for the refrigerator.

Q. And what were these tests at the Hup plant that you say you went on about?

A. As I understand it, there were two forms of construction they were working out.

Q. What did you see?

A. I did not see much of anything except the gauges that were on there showing pressure.

Q. That is, it was something like this picture you showed us in the paper, that unit you saw at the Hup plant?

A. Something similar to that.

Q. What report did Mr. Nickerson make with regard to that particular unit that he tested there?

A. I do not know as I heard Mr. Nickerson make any report on that.

Q. You did not hear his report was very unfavorable?

A. Not at that time. I did later on. At that time in 1924, Mr. Burns was not connected with the Refrigerator Products Company that I know of.

[fol. 263] Q. What were these boxes used for that you say that you saw sometime in 1923, referring to Defendant's Exhibit J?

A. To get the contents of the cylinder in solid form to use as a refrigerant. That is what I was told.

Q. Were they actually used for any purpose?

A. I have no means of knowing that, sir.

Re-direct examination.

By Mr. Darby:

I incurred a financial loss in the Refrigerator Products Company.

Q. And what were the containers shown in the newspaper article as part of the ice used for as a refrigerant of the ice box?

Mr. Kerr: I object. It does not appear he knew about it.

Q. Did you actually see that structure in use?

A. Yes.

By the Court:

Q. What was it used for, what was the purpose?

A. To take the place of ice and use as a refrigerant.

By Mr. Darby:

Q. Did it work successfully for that purpose?

A. Yes.

Q. To your knowledge?

A. It kept your temperature in the ice box around, at that time, 40.

Q. You know that of your own knowledge?

[fol. 264] A. Yes, sir; I saw the ice box myself in demonstration.

Recross-examination.

By Mr. Kerr:

Q. That time you are talking about is early March, 1924?

A. Yes. February that came to me, it was February and March that was on exhibition.

HUGH N. NICKERSON, called as a witness on behalf of the plaintiff, being duly sworn, testified as follows:

Direct examination.

By Mr. Kerr:

I am 44 years old. I live in Detroit. During 1923 and 1924 I was works manager of the Hupp Motor Car Company at Detroit.

Q. Will you please state how you met Mr. Bright and Dr. Lathrop and when?

A. A gentleman, Mr. Hedican, brought them to the Hupp Motor Company and introduced them with their project and interested me in the proposition. That was either the last of October or the first of November, 1923.

Q. How did they interest you in the proposition, what did they do?

A. They showed me some snow made out of CO_2 in a piece of chamois. That was the beginning of it. They later sent me over to Mr. Sorensen and he had a sort of [fol. 265] contraption there that did not amount to very much, and I did not learn much there. Later on they got hooked up with Mr. Lavigne, who started to make a model container to hold this snow. That was, as I remember it, along in January, 1924. I went along with them and watched their experimental work at Mr. Lavigne's shop until along about the first of March. They did not seem to be making progress enough to satisfy me, especially in the amount of gas consumed, and I stated that fact, and then they asked me to build one myself to make this test on the quantity used. I did that, and that is the machine that was made at the Hup Motor Company. I changed the design slightly two or three times to try to get it working properly, and when I got as far as I thought I could go with it I put it on a test. I had been informed that the machine would operate on from one-half to one pound of gas per day, 24 hours. I hooked up a 50-pound tank to this outfit about 5 o'clock in the evening and when I got back the next morning the 50 pounds was gone. That was one of these carbon dioxide tanks which held 50 pounds of liquid. I then decided it was time to get out, so I had a chance

to get my money out to a man named Sullivan in Chicago. I was very glad to do it and did so, and handed in my resignation as vice-president and director in the corporation.

Q. How much money did you put into it?

A. About $2,000.

Q. When you say that you went over to Sorensen, just what was the demonstration there?

[fol. 266] A. They really had nothing to demonstrate there. They were in an old place, a fellow was busy putting up a stove, trying to keep the place warm. I did not see anything there. They told me they needed tubes. I rolled them 24 feet of copper tubing. I do not know what they did with it. I never saw tests made with it.

Q. Did you see them draw off snow?

A. Yes, they drew off snow in chamois.

Q. From one of these carbon dioxide containers?

A. Yes, sir; they had no equipment except the chamois and the piece of copper tubing running from the tank.

Q. Have you anything to indicate when this machine was built at the Hup plant?

A. I have the records taken from the files of the Hup Motor Company. I did not keep any files myself. I got them from the Hup Motor before I came down here.

Q. What do those show?

A. They show the shop order the day the requisition was put through for the shop order the date the shop order was completed, and the amount charged to the order.

Mr. Darby: This is our testimony. This took place in 1924. You are trying to prove something we do not dispute. The testimony of our witness was it was around March, 1924. That is not disputed.

Mr. Kerr: I want to show we have the records here.

Q. In any of these tests did you ascertain the amount of [fol. 267] snow that was being made in these units?

A. No, the only positive test I had was the time I turned the tank on and left it go until it was empty.

Q. What was the temperature of the refrigerator the next morning?

A. Down between 44 and 46.

Q. How long did it stay down?

A. It was in a small room and I did not pay much attention after that. I just shut the room up and let the machine stay there. How long the ice lasted in the tube or how long the temperature stayed cold I do not know. I know the tank was empty before I disconnected it. In all of these machines these refrigerators, or all of these units which were developed by the Refrigerator Products Company, the CO_2 was supplied from the usual CO_2 liquid tanks. The liquid was led into the refrigerator and expanded in the unit that was in there.

No cross-examination.

Mr. Kerr: During the defendant's testimony I said I would like very much to take the testimony of another witness.

The Court: Very well.

[fol. 268] WALTER L. DITMARS recalled in rebuttal:

By Mr. Kerr:

Q. When the Carbice Corporation started in business you obtained the liquid CO_2 from the General Carbonic Company at its Long Island City plant, and converted that liquid CO_2 into solid carbon dioxide, did you not?

A. Yes.

(Winess excused.)

Mr. Kerr: That is our case, your Honor.

(Briefs to be submitted. Decision reserved.)

(Here follows drawing, side folio 269)

PLAINTIFF'S EXHIBIT NO. 1

269

Aug. 10, 1926. 1,595,426

T. B. SLATE

REFRIGERATING APPARATUS

Original Filed Jan. 10, 1924

Fig. 1.

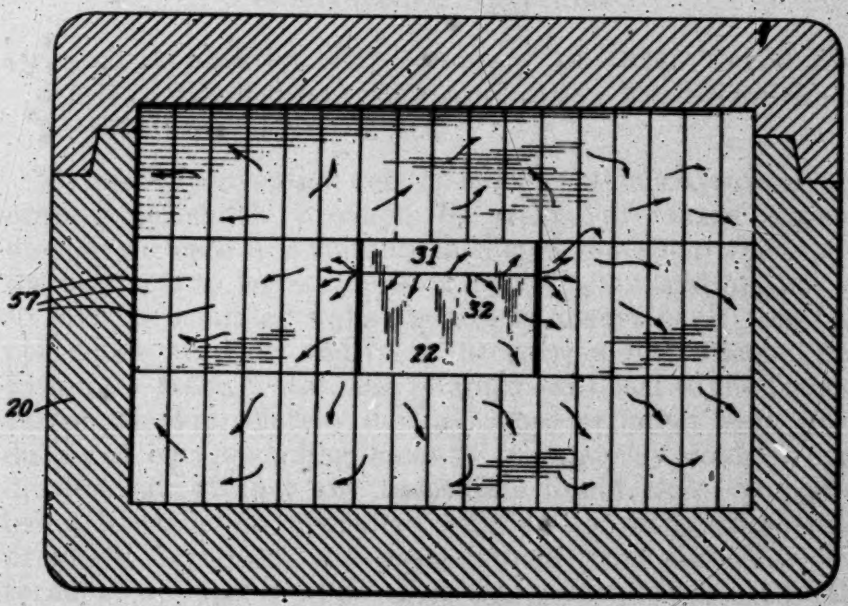
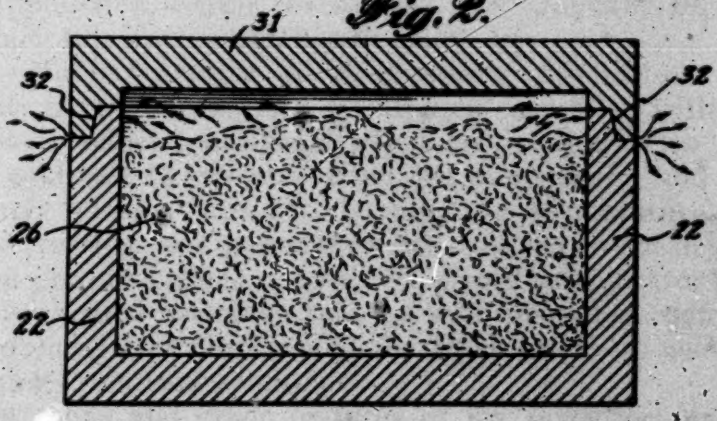


Fig. 2.



INVENTOR
Thomas B. Slate
BY
Geo. C. Shaw
ATTORNEY

[fol. 270] Patented Aug. 10, 1926. 1,595,426

United States Patent Office.

Thomas B. Slate, of New York, N. Y., Assignor, by Mesne Assignments, to International Patents Holding Corporation, of New York, N. Y., a Corporation of Delaware

Refrigerating Apparatus

Original Application Filed January 10, 1924. Serial No. 685,482. Divided and This Application Filed September 27, 1924. Serial No. 740,164

My present invention relates more particularly to refrigerating perishable products by means of frozen carbon dioxide enclosed in a suitably insulated container which has the products to be refrigerated above, below and around it so that its insulated walls operate to absorb heat from the perishable products and from the surrounding atmosphere within the refrigerator, and to apply said heat to the frozen carbon dioxide whereby it is absorbed as latent heat, producing a corresponding amount of intensely cold carbon dioxide gas without any immediate liquid state, said gas being liberated in operative relation to refrigerate such products, dry them, and protect them from air. Various forms of apparatus working on this principle are set forth in my Patent No. 1,511,306, granted October 14, 1924, on my application, Serial No. 685,482, filed January 10, 1924 of which this application is a division.

The subject matter of this present application is a heavily insulated package or shipping case filled with perishable products, preferably such as is desired to keep very cold and to preserve from the atmosphere, and particularly such as are not damaged by temperatures far below freezing, as for instance, yeast or ice cream or hard frozen products which are packed in said refrigerator case, in close heated exchange relation with insulated container of frozen carbon dioxide and the fresh intensely cold gas escaping from said container.

The above and other features of my invention may be more fully understood from the following description in connection with the accompanying drawings; in which—

Fig. 1 is a vertical section through a shipping case con-

taining food products and a carbon dioxide snow chamber or refrigerant container in the center thereof; and

Fig. 2 is a vertical section through the chamber 22.

As shown in these drawings, I provide a simple means using the insulated container 22 for the frozen carbon dioxide within a small shipping box or refrigerator 20 for the shipment of small quantities of perishable products 57, which are thus easily and efficiently refrigerated. By making snow chamber 22 of the proper size to displace a given number of packages of the perishable products to be shipped and by filling chamber 22 with frozen carbon dioxide and placing it in the midst of the said products shipped, it will slowly and gradually refrigerate those products by the escaping gas which forces its way under the lid of chamber 22 and continously keeps the air and moisture displaced.

The container 22 for the frozen carbon dioxide, as also the shipping container 20, may be of balsa wood, but may have the vacuum-wall type of insulation if found desirable. As shown, the covers of both the shipping box and the refrigerant container are close-fitting, and the walls are of exceptional thickness.

As stated in my prior application, carbon dioxide snow as deposited, is light and porous, but I prefer to use it in ice form, made either by highly compressing the snow or by freezing the carbon dioxide directly. As the carbon dioxide ice is nearly twice as dense as water ice and affords nearly twice as much refrigerant value per pound, it is particularly desirable for shipping purposes where express or freight charges are important.

In this form of my invention where the container or the carbon dioxide is midway of the products to be preserved, it is evident that the insulation cannot prevent freezing of some or all of said product because, regardless of insulation, the fresh gas escaping from the inner container impinges directly on adjacent products before it has any opportunity to diffuse or to become warmed the 140° or more F. which would be required to reach the relatively high freezing point of water.

From the above, it will be evident that my present invention differs from all the other forms described in my said prior application and patent in the particular that the carbon dioxide snow or ice refrigerant is in or among

packages or masses of the perishable products whereby certain portions of the perishable products are in close proximity to this intense refrigerant, as for instance, portions of packages in contact with the refrigerant container, while other portions are relatively remote, as for instance, those near or in contact with the [fol. 271] outer walls of the shipping or storage case. Obviously, the products close to, and particularly those in contact with, the carbon dioxide container, are certain to be reduced to temperatures far below parts of the mass that are more remote. This is very different from the situation in all of the other forms shown in my said patent, wherein all of the products are refrigerated by convection currents more than by actual conduction of the heat through portions of the product that are refrigerated.

So far as concerns the specific method, my present invention is therefore clearly distinguishable from arrangements of the type shown in Fig. 15, in said patent, wherein there is a refrigerator particularly adapted for products requiring widely different temperatures, but all refrigerated from a single source by convection currents which take effect first on the products that are not damaged by over-freezing and subsequently on other products that are not to be frozen. As contrasted with this, the specific method hereof contemplates a box or case in which all of the products to be refrigerated are of the same kind; all of them, even the remotest, are to be kept near or below freezing; and none of them are damaged by severe over-freezing that will occur in those portions most directly exposed to the refrigerant.

I claim:

1. A package for transporting and preserving masses or parcels of a perishable product of the type not damaged by severe over-freezing which consists of an outer insulated container, in which are packed masses or parcels of such perishable products in close proximity to an insulated inner container enclosing a quantity of frozen carbon dioxide which on absorption of heat through the insulation of said container, passes directly from the solid to the gaseous state; said inner container permitting the carbon dioxide gas, as formed, to escape in freezing proximity to said masses or parcels of said perishable product.

2. A heavily insulated package enclosing in close proximity to a parcel or mass of material not damaged by overfreezing during shipment, a quantity of frozen carbon dioxide insulated from but in freezing relation to said parcel or mass so that portions of the material are more directly and intensely refrigerated than other portions for the purpose and with the result of sufficiently refrigerating more remote portions, whereby on absorption of heat through said insulation, said carbon dioxide passes directly from the solid to the gaseous state; and said gas, as formed, escapes in freezing and insulating relation to said materials.

3. A transportation package consisting of a vented protective casing of insulating material enclosing a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product in freezing proximity to said carbon dioxide and the gas evaporated therefrom and arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

4. A protective casing of insulating material having therein a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product separated from but in freezing proximity to said frozen carbon dioxide and insulated by the gas evaporated therefrom.

5. A protective casing of insulating material having therein a quantity of frozen carbon dioxide in an insulating container and a quantity of freezable product in freezing proximity to said frozen carbon dioxide and insulated by the gas evaporated therefrom.

6. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of frozen carbon dioxide in an insulating container and a quantity of freezable product in freezing proximity to said frozen carbon dioxide and the gas evaporated therefrom, arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

7. A transportation package consisting of a vented protective casing of insulating material having packed therein

a quantity of freezable product in freezing proximity to a quantity of frozen carbon dioxide sufficient to afford the desired amount of refrigeration.

8. The combination of a shipping case to be refrigerated, a container of frozen carbon dioxide packed in the case with perishable products, said container being formed of or including substantial insulating means in contact with said perishable products, the capacity of the container being proportioned to the size and contents of the package to be refrigerated so as to maintain the products in frozen condition for the desired length of time by the refrigerating, preserving and moisture absorbing action of escaping carbon dioxide gas produced by the evaporation of the frozen carbon dioxide within the aforesaid container, under normal conditions.

9. An insulated shipping case, similar parcels of perishable products packed solidly in said case, surrounding and supporting an insulated container of frozen carbon dioxide, having dimensions corresponding to and fitting among the said parcels.

10. An outer thick walled balsa wood case or box containing like parcels of perishable products; and an inner [fol. 272] insulated container for frozen carbon dioxide of much smaller size, located within said outer case and in direct contact with, and absorbing heat from, and discharging resultant cold carbon dioxide among parcels of said perishable products; the capacity of said container and its insulation being proportioned to the amount of refrigeration required by said products.

Signed at New York city in the county of New York, and State of New York, this 23rd day of September, A. D. 1924.

Thomas B. Slate.

[fol. 273] IN UNITED STATES DISTRICT COURT

[Title omitted]

STIPULATION AS TO PLAINTIFF'S EXHIBITS 2, 3, 4, 5 AND 6

It is hereby stipulated that the following abstract of plaintiffs' title papers may be reproduced in lieu of Plaintiffs' Exhibits 2, 3, 4, 5 and 6 offered in evidence.

Exhibit 2. Agreement dated February 18, 1927, between International Patents Holding Corporation, a Delaware Corporation, party of the first part, Alexander Louria, Henry W. Louria and Samuel H. Hurwitz, parties of the second part, and International Patents Fiscal Corporation, a New York Corporation, party of the third part, in which

"the party of the first part does hereby transfer and assign [fol. 274] to the party of the third part all the right, title and interest of the party of the first part, of in and to the Slate refrigeration patents and patent rights more particularly described and set forth in a certain agreement entered into between Thomas B. Slate and Walter S. Josephson under date of December 8, 1925, and assigned by Walter S. Josephson to the party of the first part by assignment dated January 4, 1926, a schedule of which patents and patent applications is annexed to this agreement and marked 'Schedule A',"

subject to the indebtedness of the party of the first part to the parties of the second part in the sum of $11,000 for advances to pay for Slate's interest in the patents. Schedule A recites the United States patent 1,511,306, dated October 14, 1924, and application Serial No. 740,164, filed September 27, 1924.

Exhibit 3. Agreement dated June 10, 1927, between International Patents Holding Corporation, International Patents Fiscal Corporation, J. Gibson Fruin, parties of the first part, and Benjamin W. Reuben, party of the second part, which recites that the agreement of December 8, 1925, transferred from Slate to Josephson various inventions including application Serial No. 740,164 filed September 27, 1924, and U. S. patent 1,511,306 granted October 14, 1924. The agreement provides that the parties of the first part

[fol. 275] "sell, assign and transfer unto the said Benjamin W. Reuben the whole right, title and interest in and to the contract between Thomas B. Slate and Walter S. Josephson dated December 8, 1925, including the applications for patents and patents mentioned in said contract, subject to claim against said patents in the sum of Eleven Thousand Dollars ($11,000) held by Alexander Louria, Henry W. Louria and Samuel H. Hurwitz; the same to be held and enjoyed by the said Benjamin W. Reuben for his own use

and behoof and for his legal representatives or assigns, to the full end of the term for which said Letters Patents are granted, including the full and exclusive right to any inventions as covered by applications for Letters Patent of the United States, and the undersigned hereby requests the Commissioner of Patents to issue said Letters Patents on said applications to Benjamin W. Reuben or his assignee or legal representative."

Attached to the agreement of June 10, 1927, is the following document, dated June 10, 1927, executed by Benjamin W. Reuben, forming a part of Exhibit 3, which recites:

"Know all men by these presents:

"That the undersigned, Benjamin W. Reuben, for and in consideration of the sum of One Dollar and other valuable [fol. 276] considerations, the receipt of which is hereby acknowledged, hereby sells, assigns, transfers and sets over to the American Patents Development Corporation, a Delaware Corporation, all of his right, title and interest in a certain contract dated June 10, 1927, between International Patents Holding Corporation, International Patents Fiscal Corporation and J. Gibson Fruin, parties of the first part, and Benjamin W. Reuben party of the second part, copy of which contract is annexed hereto and made a part hereof."

Exhibit 4 is a transfer from Benjamin W. Reuben to plaintiff American Patents Development Corporation, executed December 29, 1927, which in the preamble recites various patents and applications of Thomas B. Slate, including the patent in suit, No. 1,595,426, dated August 10, 1926. The conveying part of the agreement recites:

"Now, therefore, in consideration of the sum of One Dollar and other valuable considerations, receipt whereof is hereby acknowledged, the said Reuben by these presents does hereby sell, assign, transfer and set over to said American Patents Development Corporation, its successors or assigns, the whole right, title and interest in and to the said inventions, patents and applications, and all of his right, title and interest in and to the said contract dated December [fol. 277] 8, 1925; subject, however, to the provisions of said contract of June 10, 1927, and to the exclusive license

granted on December 3, 1924, by the said State to the Prest-Air Corporation, to which rights the Dry Ice Corporation of America has succeeded, the same to be held and enjoyed by the said American Patents Development Corporation for its own use and behoof, and for that of its successors and assigns, to the full end of the term or terms for which the said Letters Patent are or may be granted, and the undersigned hereby requests the Commissioner of Patents to issue said Letters Patent on said applications to American Patents Development Corporation, or its successors or assigns."

Exhibit 5 is an agreement, dated December 3, 1924, between Thomas B. Slate, of Glendale, California, and Prest-Air Corporation, a Delaware corporation, which recites that Slate is the sole inventor of inventions and improvements relating to refrigeration, etc., specifically including those set forth in the following applications for letters patent: Serial No. 685,482, filed January 10, 1924, and Serial No. 470,164, filed September 27, 1924, upon which the patent in suit issued. The agreement provides:

"First. Said Slate hereby grants to the Company the sole and exclusive license and right to make, have made, use, install, sell, lease or otherwise dispose of, throughout the [fol. 278] world, any and all apparatus, appliances and machines embodying any and all inventions, improvements, processes and/or methods in or relating to the above mentioned inventions; as well as the entire and exclusive right to make, have made, use, install, sell, lease or otherwise dispose of any and all devices, inventions or improvements disclosed or described in said above specified Letters Patent and applications therefor, under said Letters Patent and under said applications and under any and all divisions, renewals, or continuations thereof, and under any and all United States or foreign patents, original, reissued or extended, that are or may be granted thereon; as well as the exclusive license and right to practice any and all methods and processes involving any and all inventions and improvements disclosed or described in said above specified Letters Patent and applications therefor; as well as the exclusive license and right to make, have made, use, sell or otherwise dispose of frozen and/or liquid carbon dioxide;

the said exclusive license being for the United States and territorial possessions thereof and for all other countries of the world, for the full end of the term hereinafter specified; also specifically including similar exclusive licenses and rights for any and all past, present or future inventions, applications, patents, licenses or interests in applications or patents, whether now owned or controlled or invented or [fol. 279] hereafter to be owned or controlled or invented by said Slate, whether severally or jointly with others, relating to the same field or subject matter of the invention, or tending to supplement or to improve or to supplant or to compete with said inventions or any of them; also the sole and exclusive right to apply for and obtain Letters Patent in all foreign countries on any and all inventions or improvements covered or hereafter to be covered by this agreement; all of said exclusive licenses and rights in the United States and/or any and all territories and countries of the world, to be only under and subject to the terms and conditions hereinafter set forth, violation of any of which by the Company shall give said Slate the right to terminate this agreement as hereinafter provided."

Under paragraphs First (4), Second and Eighth the Company's right to assign the license is recognized.

Exhibit 6 is an assignment to the Dry Ice Corporation of America, a Delaware corporation organized in 1927, of a license from the Dry Ice Corporation of America, a Delaware corporation organized in 1922, the name of which was originally the Prest-Air Corporation and which had been changed by statutory proceedings. The assignment specifically mentions Slate patents 1,511,306, dated October 14, 1924, and 1,595,426, dated August 10, 1926, as being in- [fol. 280] cluded in the subject matter thereof. The conveying portion of the agreement provides:

"Now, therefore, in consideration of the sum of One ($1.00) Dollar and other valuable consideration, the receipt whereof is hereby acknowledged, the party of the first part, by these presents, does give, grant, sell, assign, transfer and set over unto the party of the second part, its successors and assigns, all the right, title and interest of every nature and character, past, present and future, of the party of the first part in and to the said license agreement and in

and to any and all of the said patent and application rights, title and interest for the United States of America and for all foreign countries, for the full end of the term of the said license agreement, and all renewals and extensions thereof, subject to the terms and conditions set forth in said license agreement, the same to be held and enjoyed by the party of the second part, for its own use and behoof and for the use and behoof of its successors and assigns, as fully and entirely as the same would have been held and enjoyed by the party of the first part had this assignment and sale not been made.

"This grant and assignment specifically includes all of the right, title and interest, of every nature and character, of the party of the first part, of, in and to the said license agreement, and the subject matter thereof, including all [fol. 281] royalties, license fees, profits and all manner of actions, causes of actions, suits, debts, dues, sums of money, accounts, reckonings, covenants, contracts, controversies, agreements, promises, variances, trespasses, damages, claims and demands whatsoever, in law or in equity, which the party of the first part ever had, now has, or which the party of the first part, its successors or assigns, hereafter can, shall or may have against any person, firm, corporation or other association for, upon or by reason of any matter, cause or thing whatsoever arising out of or resulting or accruing from or out of the said license agreement, and the rights and interest therein granted, from the date of the said agreement to the day of the date of these presents.

"This assignment is subject, however, to any and all grants, licenses, sublicenses, assignments or other rights and interests which the party of the first part, prior to the day of the date of these presents, may have made, granted, given or conveyed, to any other person, firm, corporation or other association out of or in and to a portion of the right, title and interest which the party of the first part had or may have had in said license agreement, or in the subject matter thereof and inconsistent with or in limitation of the grant, assignment and transfer to the party of the second part hereunder.

"The party of the second part does hereby assume and [fol. 282] agree to perform all of the terms, covenants and conditions set forth and described in the said license agree-

PLAINTIFF'S EXHIBIT No. 7

283

CABLE ADDRESS
DRYICE

PHONE
MURRAY HILL 2910

DRYICE TRADE MARK
CORPORATION OF AMERICA
50 EAST 42nd STREET,
NEW YORK

INVOICE DATE

INVOICE NO.

To DRYICE CORPORATION OF AMERICA, Dr. $

Please detach the above stub and mail it with your cheque. Retain this portion of the bill for your records. Your cancelled cheque will be your receipt.

TERMS: NET CASH

DRYICE SUPPLIED DURING WEEK ENDED

CARTONS, ETC.,

TOTAL

(FOR DETAILS SEE ATTACHED DELIVERY RECORD NO.

The merchandise herein described is shipped upon the following condition: That Dryice shall ale be used except in Dryice Cabinets or other containers or apparatus provided or approved by the Dryice Corporation of America; and that Dryice Cabinets or other containers or apparatus provided or approved by the Dryice Corporation of America shall be refrigerated or used only with Dryice. These uses of Dryice are fully covered by our Basic Method and Apparatus Patent No. 1,311,305. Granted October 14th, 1924, and other Patents Pending.

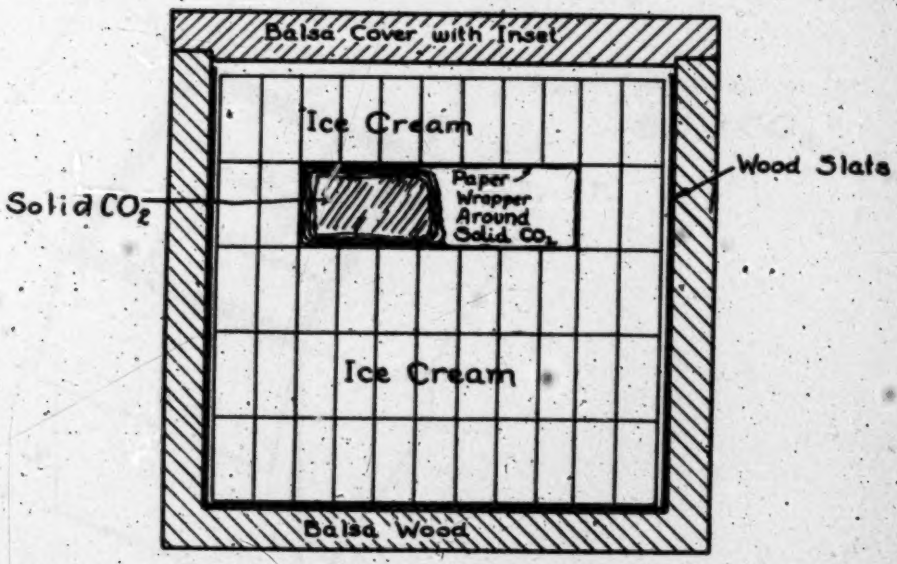
AM. PATS. DEVELOPMENT CO.,

VS.

CARBICE

IN EQUITY

No 3119

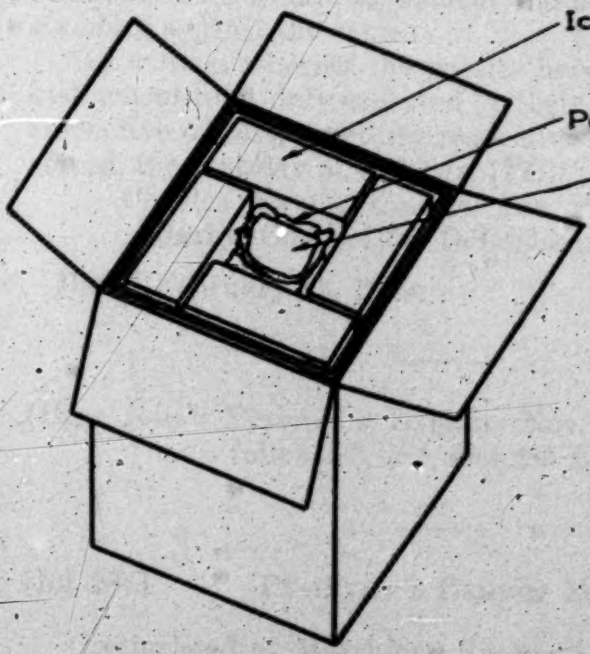


MARCHIONY

SHIPPING CASE.

PLAINTIFF'S EXHIBIT No. 12 285=286

AM. PATS. DEVELOPMENT CO.,
VS.
CARBICE
IN EQUITY
No 3119



MARCHIONY
SHIPPING CARTON

ment dated December 3, 1924, hereby assigned, so far as compliance and performance thereof are required by the party of the first part thereunder.

"The party of the second part does further hereby assume and agree to perform all of the terms, conditions and covenants of any and all grants, licenses, sublicenses, assignments or other rights and interests which the party of the first part prior to the date hereof, may have made, granted, given or conveyed, to any other person, firm, corporation or other association out of or in and to a portion of the right, title and interest of the party of the first part in and to the said license agreement and now existing and outstanding against the same.

"In witness whereof the parties hereto have caused this instrument to be duly executed by their properly authorized respective officers, and their respective seals to be hereunto affixed, the 31st day of October, 1927."

Charles Neave, Counsel for Plaintiffs. Darby & Darby, Counsel for Defendants.

Dated February 13, 1929.

(Here follow Plaintiff's Exhibits Nos. 7, 11, and 12, side folios 283, 284, and 285 & 286)

[fol. 287] PLAINTIFF'S EXHIBIT No. 13

(Letterhead of Marchiony Spumoni Company, Inc.)

March Fifteenth, 1927.

Carbice Corp., Sixth Street & East River, Long Island City, N. Y.

Att. Mr. Clark.

DEAR SIR: Referring to your offer to sell us Dry ice at 4½¢ per pound, as this is cheaper than we are able to buy carbon dioxide from the Dryice Corporation, we are willing to try your product at the price in question, provided that you will give us a written assurance that it will give us as satisfactory results in shipping ice cream under our present

conditions of use as the product of the Dryice Corporation and you will be prepared to keep us supplied after we begin using it.

In justice to ourselves, we cannot change our present source of supply other than as above stated.

Yours very truly, Marchiony Spumoni Company, Inc. —— ——, President.

LSM:MH.

[fol. 288] PLAINTIFF'S EXHIBIT No. 14

(Letterhead of Carbice Corporation)

March 18, 1927.

Marchiony Spumoni Co., Inc., 157 Bleecker St., New York City.

GENTLEMEN: Replying to your letter of March 15th, we hereby guarantee to make daily deliveries of Carbice to you in any quantities you may desire. Further, in an emergency, we will make delivery to you within two hours, between 8 A. M. and 6 P. M.

We also guarantee that Carbice will be found as satisfactory as dry ice in any and every way, and being made under greater compression than the latter product, will prove to be a more efficient refrigerant.

Assuring you we will cooperate with you in every way and advise you as to the most economical use of our product, we remain,

Very truly yours, Carbice Corporation of America.
I. R. Clark, Sales Director.

[fol. 289] PLAINTIFF'S EXHIBIT No. 15

(Copy)

(Letterhead of Dean, Fairbank, Obrieght & Hirsch)

October 27, 1926.

Mr. W. E. Ditmars, care of General Carbonic Co., Sixth Street and East River, Long Island City, New York.

DEAR SIR: I write you at the request and in behalf of my client, DryIce Corporation of America, No. 50 East 42nd

Street, New York City, New York, to give you this formal notice of your various acts of infringement of my client's rights, particularly infringement of various of my client's patents, including United States patents to Slate Nos. 1,511,306, granted October 14th, 1924, 1,595,426, granted August 10th, 1926, and Cusack No. 1,595,385, granted August 10th 1926 etc.

Your said acts include not only your individual acts of infringement, for which you alone are liable, but also acts in concert or conspiracy with others, including Southern Dairies, Inc., of No. 60 M Street, N. E., Washington, D. C., and General Carbonic Company, Inc., of No. 17 West 46th Street, New York City, New York, with both of which companies you appear to be intimately associated. Such acts include making or procuring frozen carbon dioxide by some [fol. 290] or all of you, particularly by you and by General Carbonic Company, for the purpose and with the result of causing its use in infringement of my client's said patents, by some of you, or by all of you, or by others, particularly by Southern Dairies, Inc., and by you, Mr. Ditmars.

One variety of the wrongful and infringing acts by some or all of you, particularly by you, Mr. Ditmars, has been the direct solicitation of orders for furnishing frozen carbon dioxide to customers and prospective customers of my client, for use in direct infringement of said patents of my client.

While my client's patent rights and contracts of sale whereby said customers obtain a license under its patents and particularly its offer of such license to Southern Dairies, are well known to each and all of you, such offers having been made directly to and through you, Mr. Ditmars; and while your above acts of infringement, unfair competition, interference with contracts, conspiracy, etc., are no doubt deliberate, this is to give you formal notice thereof and to call upon you to desist and refrain from any and all such acts of infringement, or stand suit.

Yours very truly, George C. Dean.

GCD:NES.

[fol. 291] PLAINTIFF'S EXHIBIT No. 16

Electric Refrigeration News, December 21, 1927

Applications of Carbon Dioxide Ice Explained

Particularly Adapted to Carload Shipments of Perishables

(Editor's Note.—Excerpts from an address by Walter E. Ditmars, president of Carbice Corp., New York City, delivered at the 21st annual meeting of the Eastern Ice Association in New York City, Nov. 29-Dec. 1.)

Artificial refrigeration is not a recent innovation. From the moment when the physicist first found the relationship of pressure to temperature, new discoveries were constantly being made by scientists working this field. First successfully demon-trated more than a century ago, artificial refrigeration was not put into general use until the last decade of the past century, mechanical refrigeration following by about ten years. Now artificial refrigeration is indispensable to the people of the United States and is responsible, to a large degree, for the nation-wide foodstuffs markets that have been opened up.

Until recently scientists and engineers have concerned themselves mainly with producing ice from water and yet the use of carbon dioxide as a refrigerating agent was universally known many years ago. Used mechanically to a limited extent, carbon dioxide refrigeration now has been developed on a commercial scale along non-mechanical lines.

Theoretically any gas by sufficient pressure and low temperature can be liquefied or even frozen solid and actually nearly all gases have been liquefied. Carbon dioxide, the well known gas of almost universal distribution, has been known and used commercially in liquid form for years, for soda water gas and for many other purposes. It has now come into commercial use frozen into a solid. Unlike ordinary ice, solid carbonic does not melt, but rather evaporates as a gas, leaving no wet, sloppy residue. It is interesting to note more fully the nature of solid carbonic, its properties and how it is made.

Gas is Entirely Safe

Carbon dioxide, CO_2 at ordinary temperature, and at atmospheric pressure, is a gas, fully oxidized carbon. Unlike carbon monoxide (CO), the partially oxidized carbon, which is deadly poisonous, carbon dioxide is entirely harmless—in fact, we exhale it in our breath. It is present in the air to the extent of about 3 parts to 10,000. It is produced whenever carbonaceous matter burns in air. When a ton of coke is burned, upwards of three tons of carbon dioxide passes up the flue. It is the gas produced in alcoholic fermentation. Breweries, alcohol plants and sugar refineries produce large quantities of it. It is also driven off when limestone or marble is reduced to lime. It is a colorless, odorless gas, having the pleasing taste familiar in carbonated water. It is about 1½ times as heavy as air, volume for volume, if the pressure of the air and gas are the same. It is not inflammable and does not support combustion—in fact, it is an excellent fire extinguisher.

This gas, when compressed to about 1,000 pounds per square inch, and at temperature of about 80° F., liquefies. This is the liquid that is shipped in steel cylinders, and is used for carbonating soft drinks. If one of these cylinders is inverted and quickly opened, the liquid rapidly expands. Some of it evaporates, and, in doing so, absorbs so much heat that a portion freezes to a snowy, white solid, carbon dioxide snow.

In the commercial manufacture of solid carbonic, liquefied CO_2, is allowed to expand through a patented nozzle into large tanks to conserve the gas, and the snow produced is hydraulically compressed into hard blocks before being exposed to the air, forming solid carbonic.

Solid carbonic is snowy white, not transparent like ordinary ice. It weighs about 80 pounds to the cubic foot, and has a temperature of 114° F. below zero (146° colder than water ice). Each pound of solid carbonic produces about 9 cubic feet of gas when warmed into ordinary room temperature. The amount of refrigeration available from it depends on the extent to which the use is made of the refrigeration in the gas. The following table shows the number of B. T. U. absorbed, the gas being warmed to the temperature indicated.

Final temperatures of gas F.	B. T. U. per Lb.
10	249
0	256
20	267
32	274
75	346

Solid carbonic, therefore, contains roughtly twice as much refrigeration, pound for pound, as ordinary ice, which absorbs 144 B. T. U. per pound at 32° F.

Far More Effective Than Water Ice

To use solid carbonic it is essential, however, that we bear in many that its properties are different in many ways from ordinary water ice. The gas formed from solid carbonic, being heavier than air, quickly sinks and if in a container will fill the container and overflow the top as if it were an invisible liquid. Since a pound of solid carbonic produces 9 cubic feet of gas, means of escape must be left for the gas. Such means are always present in ordinary insulated shipping containers, balsa wood shipping boxes and corrugated paper containers. The cold generated gas, however, forces out the warm air before it and prevents the access of more warm air. This pushing out of warm air before it very effectually keeps the container cold, because the only way the inside of the container can be warmed is by actual conduction of heat through the walls and through the cold gas itself, which is slowly coming out of the container. Ordinary water ice, if used, turns to water, does not increase in volume and runs out, allowing warm air to enter. The expanding property of solid carbonic serves to make it from 15 to 20 times as effective as ordinary ice, at the same time guaranteeing a clean, dry package. If the solid carbonic is so packed that it surrounds itself with cold gas, its rate of evaporation is slowed up materially and it lasts much longer.

There is no adverse effect of the cold gas on ice cream, meat, fish, etc. In fact, frozen fish has been kept in an atmosphere of cold carbon dioxide for six months without the slightest effect whatever. Excluding oxygen as it does, the

gas retards the growth of ordinary bacteria and has a mild antiseptic effect.

Several of the largest and most prominent ice cream manufacturers, caterers, fish companies and meat packers are using solidified carbon dioxide for shipping purposes. Numerous tests have demonstrated to these firms the advantages of using carbon dioxide ice as a means to extend their markets tremendously.

Some Important Advantages

The advantages of solid carbonic over the old method of ice and salt for refrigeration are numerous, but below are listed some of the most important.

Shipping and Delivery.—Almost unlimited shipping radius with solid carbonic without re-icing. Increased working capacity of delivery equipment. Collections of empty tubs, cans, etc., reduced to a minimum.

Packing and Shipping Charges.—Perishables (ice cream, flowers, fish, meats, fruits etc.) may be packed earlier and shipments grouped when solid carbonic is used—no re-icing necessary. Tremendous weight and space is saved in shipping with resultant large savings in shipping charges. For example: A 5 gallon can of ice cream packed in solid carbonic in an iceless jacket or balsa- wood box weighs fifty pounds against 125-150 pounds when packed in salt and ice. This saving in weight and bulk may be applied in shipping of butter, fish, meats, etc.

Sanitation.—Clean, dry workrooms, platforms and delivery equipment. No sloppy mess in shipping containers. No inconvenient wet packages or tub in the house of the consumer. Solid carbonic is absolutely dry. The temperature is even and fixed.

Equipment.—Solid carbonic eliminates necessity for excessive depreciation of expensive equipment. Truck bodies and chassis are not damaged by it as is the case with salt and ice. Wooden and metal containers containing solid carbonic are not damaged by brine. In a great many cases light, paper, non-returnable containers may be used with solid carbonic instead of the clumsy, heavy containers necessary with salt and ice packing.

Several manufacturers have eliminated numbers of their heavy delivery trucks and have substituted motorcycles

with balsa wood side car containers which deliver small orders to homes, dealers and restaurants, faster and more economically.

Special bodies for trucks have been perfected and save practically all the space formerly used for salt and ice, thus permitting greater carrying capacity.

Carloads of fish filled to the top of the car have been sent from New York to Kansas City taking six days for the trip without re-icing and using only 1,500 pounds of carbon dioxide ice.

Concrete Data.—In the transportation of ice cream between New York and Philadelphia, experience has shown that 200 pounds of solid carbon dioxide replaces 3,000 pounds of water ice and 600 pounds of salt, an efficiency ratio of 15 to 1. In the shipment of frozen fish from New York to Detroit, 17,000 pounds of water ice and 10 per cent of that weight of salt are ordinarily consumed per car, whereas the same quantity of fish may be shipped over the same route in a frozen condition with the use of only 1,200 pounds of solid carbon dioxide, and furthermore, the carbon dioxide is all loaded at the beginning of the trip and does not require frequent replenishment.

The savings effected by the use of so convenient a refrigerant is evident from the fact that single charges of carbon dioxide have maintained perfect refrigeration in a car over a journey ordinarily requiring many re-icings.

Not only is there a saving in actual refrigerant used but ordinary practice with water ice requires that the car be taken off service approximately 20 per cent of the time of a journey for re-icing.

The large amount of water ice required by a car adds to the weight of non-paying freight and reduces the space available for pay freight. The very low temperature of solid carbon dioxide and the factor of safety which this introduces into refrigeration make it possible for a car to carry as much as 50 per cent more perishable freight than its present accustomed load.

The evaporation of carbon dioxide to a dry gas not only makes feasible its use in paper or cardboard containers for small-lot shipments without the necessity of the return of empty tubs or barrels, but for carload freight it also reduces the maintenance cost on refrigerator car equipment.

PLAINTIFF'S EXHIBIT No. 17

292

TELEPHONE
ASHLAND
9733

PLANT
37th STREET & EAST RIVER
LONG ISLAND CITY, N. Y.

CARBICE CORPORATION
OF AMERICA

100 EAST 42nd STREET NEW YORK

No Pickups When You Use Carbice

The ice and salt method of refrigerating Ice Cream, always wasteful and disagreeable, is on its way to the industrial scrapheap. Science presents CARBICE (Solidified CO-2) the new Refrigerant, with remarkable advantages to the Ice Cream Industry.

With Carbice you can ship Ice Cream by express or parcel post, without leakage or drip, in a "throw away" paper package. Whatever the distance the Ice Cream will arrive in perfect condition, without re-icing. Following are some of the outstanding advantages of Carbice over water ice and salt:

No picking up or shipping back of containers.

Extends Shipping Radius.

Greatly reduces express charges by reason of less weight and bulk and no container returns.

No re-icing during shipping.

Solves problem of retail carry-out trade and sale to auto parties, picnickers, tourists.

Permits use of delivery vehicles that are smaller, lighter, cheaper and faster, yet with more carrying capacity.

Cuts down labor cost of handling returns and in packing, delivery and shipping.

No salt in Ice Cream.

Provides clean, sanitary-appearing and smaller package; more convenient for customer to handle.

No leaking or dripping of package and no briny residue for Dealer or Consumer to dispose of.

No more tubs and cans with attendant repainting and repairs.

Eliminates depreciation on metal equipment thru damage by contact with ice and salt and wear and tear of repeated handling in delivery and collection.

Takes up less storage space.

Permits earlier packing and grouping of deliveries.

Keeps Ice Cream in perfect condition until eaten; no deleterious effect on quality or flavor.

Exact amount of Carbice can be determined for proper refrigeration of any size package for given length of time.

The new Ice Cream Refrigerant (Solidified CO-2) is of vast importance to your business. With Carbice you can deal a crushing blow to Waste and give a correspondingly tremendous impetus to Distribution, to Sales and to Profits.

If your business is affected by artificial refrigeration you ought immediately to study the applicability of Carbice. The opposite page leads straight to your Profit Sheet. Look it over and check where you wish information.

CARB-ICE

Manufactured and Distributed by

CARBICE CORPORATION OF AMERICA

1104 Pershing Square Building - 100 East 42d Street, New York City

Reprinted from the May, 1927, issue of The Ice Cream Trade Journal

You will want to know the answers to one or more of these questions

(Check points on which you wish information in industrial fields as classified below for convenience of your stenographer. Write us on your own letter head for information required and send with the coupon below.)

Group 1—To Ice Cream Manufacturers

(Check information you wish)

- [ ] Data on manufacture of "throw away" containers.
- [ ] Distance Carbice will enable you to ship.
- [ ] Data on actual use of Solidified CO-2 by several Ice Cream Manufacturers.
- [ ] Data on actual use of Solidified CO-2 by Caterers and other Retailers in carry-out and local delivery trade.
- [ ] Data on manufacture of special truck bodies and delivery vehicles.
- [ ] Point nearest to you where Carbice can be obtained.

Group 2—To Allied (Ice Cream) Manufacturers and Supply Industry

(Check fields for which you wish specific information as to applicability of Solidified CO-2)

- [ ] Packages and Containers.
- [ ] Soda Fountains (Manufacture).
- [ ] Ice Cream Novelties.
- [ ] Ice Cream Vending Machines.
- [ ] Ice Cream Cabinets.
- [ ] Truck Bodies.
- [ ] Delivery Vehicles.
- [ ] Soda Fountain (Service)

Group 3—To Miscellaneous Manufacturers and Shippers

(Check fields for which you wish specific information as to applicability of Solidified CO-2)

- [ ] Bottled Carbonated Beverages.
- [ ] Liquid Carbon Dioxide.
- [ ] Candy.
- [ ] Shipment of fruit, vegetables, eggs, cheese, butter, meat, dressed poultry, fish, oysters, flowers, and other perishables.
- [ ] Storage of perishable foods.
- [ ] Sterilization of cereal storage.
- [ ] Refrigerator Cars (Manufacture).
- [ ] Paint, Varnish and Oils.
- [ ] Fire Extinguishers.
- [ ] Household Refrigeration.
- [ ] Ship Refrigeration.
- [ ] Shipping vaccines and serums.
- [ ] Surgical and dental anesthesia.
- [ ] Separation of mixtures of low freezing hydrocarbons.
- [ ] Excavation work.

Group 4—For Technical Information

(Check where you wish answers)

- [ ] Temperature of Carbice.
- [ ] Weight of Carbice.
- [ ] Rate of evaporation.
- [ ] Heat Absorption rate.
- [ ] Efficiency ratio of Carbice compared with water ice.
- [ ] Capacity of Carbice to maintain specific temperatures.
- [ ] Effect of Carbice on bacteriological growth.

Fill out and mail coupon below for complete information on special subjects

Firm Name .....

Street .....

Town ..... State .....

Mail to Carbice Corporation of America, 1 Pershing Square, New York City.

114° BELOW ZERO

CARB-ICE

THE PERFECT DRY REFRIGERANT

The depreciation of refrigerator cars in service is very rapid, largely because of the moist cold supplied by water ice and the brine drippings from ice bunkers which must be cared for. There is also the possibility that drip pipes may become clogged and water collect around the cargo, resulting in serious damage.

(Here follows Plaintiff's Exhibit No. 17, side folios 292, 293, 294, and 295)

[fol. 296] PLAINTIFF'S EXHIBIT No. 18

London E. C. 4, 9-13 King William St. N. Y. Branch, 251 W. 57th St.

Harvey Fisk & Sons, Members New York Stock Exchange, 120 Broadway, New York

Confidential Private Offering

Solid Carbonic Company, Ltd., New York City

Capital Stock: ——

Transfer Agent: Guaranty Trust Co. of N. Y. Registrar: National City Bank of N. Y.

Mr. W. E. Ditmars, President of the Company, summarizes his letter to us as follows:

Business

The Solid Carbonic Company, Ltd. will engage in the manufacture and sale of solid carbon dioxide, adaptable, because of its temperature of 114° below zero F., refrigerating efficiency, compactness and dryness, to all perishable food stuffs, transportation, motor vehicle, steamship, and freight car refrigeration and numerous other uses. It permits lighter packing, almost unlimited shipping radius, a great saving in space and weight in ship-

ments, thereby greatly reducing the freight charges, permits direct economies in cost, and saves time now required for re-icing. Being absolutely dry it prevents the excessive depreciation of equipment due to water and brine. [fol. 297] Solid carbon dioxide is superior to water ice in practically every respect, and is free from the difficulties that attend portable mechanical refrigeration.

Property

The company will erect its first production unit at Deep Water Point, New Jersey, opposite Wilmington. This plant will be adjacent to the works of the Eastern Alcohol Corporation, a jointly owned subsidiary of E. I. Dupont de Nemours & Company and National Distillers Products Corporation, on property obtained from the Eastern Alcohol Corporation under a long term lease. Carbon dioxide will be purchased from the latter company, which will install the necessary gas purification processes at its own expense. The first production unit will have a daily capacity of more than 25 tons. As required, additional productive capacity up to 50 tons daily will be installed at Deep Water.

Capitalization

The capital of the company will consist of 200,000 shares of no par value stock. The Eastern Alcohol Corporation now owns 5,000 shares of this capital stock, and has an option to purchase 20,000 additional shares. Including this financing there will be 100,000 shares outstanding, leaving 100,000 shares in the Treasury.

Present Market

The company has acquired over 51 percent of the capital [fol. 298] stock of the Carbice Corporation of America, which corporation is now selling solid carbon dioxide to:

Frank G. Shattuck Company.
Reid Ice Cream Company.
Hershey Creameries.
Huylers.
Cons. Dairy Products Co.

U. S. Dept. of Agriculture.
Bryer Ice Cream Co. Philadelphia.
Southern Dairies Co. Inc. Washington, D. C.
E. R. Squibb & Son, New York.
Maresi-Mazetti Corp.
Louis Sherry, Inc.
Hydrox Ice Cream Co.
DuBarry.
Longchamps.
Rutleys, Inc.
Supplee-Wills-Jones Company, Philadelphia.
Colonial Ice Cream Company, Philadelphia.
Burdan Brothers, Philadelphia.
Crane Ice Cream Company, Philadelphia.
Philadelphia Dairy Products Co., Philadelphia.
Adolf Gobel, Philadelphia.

An excellent market, hitherto limited by uncertainty of supplies of raw materials and other factors is now open.

Prospective Markets

Solid carbon dioxide is particularly well adapted to the ice cream industry, which in 1926 consumed 9,600,000,000 pounds of water-ice, and 1,600,000,000 pounds of salt for packing, shipping and delivery purposes. We have calculated an average delivery cost of 25 cents per gallon of ice [fol. 299] cream under present methods of water ice and salt refrigeration. With solid carbon dioxide refrigeration, our carefully detailed studies show that a net saving of from 10 cents to 17 cents, per gallon on delivery costs may be effected. Inasmuch as 322,792 gallons of ice cream were delivered in the United States in 1926, the various extent of the market is obvious.

Solid carbon dioxide refrigeration is adaptable to the transport of every kind of perishable food. The increased shipment range and saving in time will also greatly broaden the markets for out-of-season produce from the Southern and Pacific States. Extensive potential marketing possibilities exist in the dairy, meat and fish industries. Extensive interest is being shown by the leaders in these fields.

Cost and Competition

Our contract with the Eastern Alcohol Corporation assures an ample supply of raw material, carbon dioxide gas, at a price permitting a substantial profit in direct competition with water-ice. Our contract permits also a reliance on a raw material supply that makes possible an aggressive campaign for sales. Low costs will enable us to compete on most favorable terms with makers of water-ice, and with other companies in the same business. Negotiations have also been entered into with other important manufacturers who produce carbon dioxide gas as a by-product, for similar manufacturing facilities at the Alcohol plants of those companies.

[fol. 300]

Future

Production is expected to begin April 1st, 1928. The company will adopt the policy of devoting a large part of earnings to expanding production and building up resources, and further production units will be built as the demand develops.

Management

The management of this company consists of men of wide experience in the refrigeration industry, and particularly in solid carbon dioxide refrigeration.

The research, engineering and distribution departments will be in the hands of men regarded as the foremost authorities in the country in their respective fields and they will have the assistance and counsel in their respective lines, of the engineers of the company purchasing the stock as above outlined.

The Board of Directors includes the following: John C. Collingwood of Harvey Fisk & Sons; Walter E. Ditmars, President; Theodore Revillion of Harvey Fisk & Sons; P. A. Rogers, Vice President, Eastern Alcohol Corporation, and John A. Voetsch, President of the Olney Bank and Trust Company, Philadelphia.

We offer as a speculation a limited number of shares of capital stock of the Solid Carbonic Company, Ltd., when

as and if issued, at $10. a share, subject to prior sale and change in price.

Harvey Fisk & Sons.

[fol. 301] PLAINTIFF'S EXHIBIT No. 20

April 16, 1927.

Carbice Company of America, 6th Street and East River, Long Island City, N. Y.

DEAR SIRS: We are advised that you are infringing the exclusive rights of our client, The Dry Ice Corporation of America, in U. S. patents Nos. 1,511,306, 1,595,426 and 1,595,385, by selling frozen carbon dioxide with the intent that such product shall be used in infringement of the patents aforesaid.

You are requested immediately to cease your acts in derogation of our client's rights, and to advise us of the amount of frozen carbon dioxide you have sold.

In the event that you do not promptly comply with our request, we have been instructed to file suit against you.

Very truly yours, Fish, Richardson & Neave.

K:T.

[fol. 302] PLAINTIFF'S EXHIBIT No. 21

Ice and Refrigeration

Dry Ice—Solidified Carbon Dioxide

Interesting Discussion of this Substance Which Author Says Has Enough Plausibilities and Possibilities of Successful Application to Give It a Good Start in a Promotional Way, Yet Its Commercial Possibilities and Eventual Success as a Profitable Method is Quite Limited

By J. C. Goosmann

During the last few years a substance has appeared for introduction into the market which has been given the trade name "Dry Ice."

Many claims of usefulness are made for this substance and set forth in specific literature, at ocular demonstrations and in the offices of promoters.

Some of these claims are based upon truth and fact, others are far off the mark and the rest are probably misconceived and, therefore, erroneously stated. The conclusions are misleading and the statements of practical usefulness on a competitive commercial basis with water ice, as to cost and resultant effect, are entirely false.

Clever exploiters have often employed certain dazzling demonstrations with diversified substances for personal gain rather than the establishment of actual usefulness. Sometimes these demonstrations are electrical in nature; at other times they are chemical and quite often they belong to materials taken from nature's realm having the facility of changing their condition accompanied by startling actions and reactions which to the layman appear nothing short of miraculous.

One of the most notorious cases in point was that of Professor Tripler's method of producing liquid air in quantities. The preposterous claims made for the unlimited usefulness of this substance, particularly in the field of practical refrigeration, involved almost to the point of criminality and forever destroyed his reputation as a serious scientist.

Mechanical refrigeration has come in for a goodly share of fake promotions. Many of them had a sufficient number of seemingly plausible, promising, yet mysterious elements in them to induce investors to part with their cash on the promised chance of big gains, in spite of the fact that competent scientists and engineers had already disclosed their real nature and warned against them. It seems that particularly the element of mystery takes possession of the layman's otherwise good business judgment and induces him to unloosen his purse strings, which in many cases of real merit remain tightly drawn, because the inexplicable and mysterious element as well as the promise of fabulous gain are conspicuously absent.

Other enterprises quite frequently contain a fair basis for success and are often promoted in perfect good faith but with an evident deficiency in the full knowledge of the subject which prevents the honest disclosure of the unfavorable side of the question.

"Dry Ice" seems to belong to this category. It has enough plausibility and possibility of successful application in it to give it quite a start in a promotional way. Yet, its commercial possibility and eventful success as a profitable method is quite limited, which will become easily and thoroughly apparent upon the consideration of the following facts:

What Is Dry Ice?

"Dry Ice" is a trade name for solidified carbon dioxide, coined to emphasize the fact that the evaporation of this medium from its solid form into gas is a perfectly dry process, in direct distinction from water ice, which returns from the solid state into water and from which it came. In substance, "Dry Ice" is carbon dioxide in its solid condition.

It is well known that carbon dioxide does not and can not exist in the form of a liquid at the pressure and temperature of the atmosphere for the following reasons:

The evaporating temperature of liquid carbon dioxide at atmospheric pressure is 110° F., but long before this low temperature is reached it has a tendency to congeal and will do so at 75° and a pressure of 50 pounds gage. Therefore, whenever a sufficient quantity of wet vapor is discharged from a liquid container through a valve into the atmosphere it appears partly as a dry gas and partly in the form of very fine crystals which may be observed in the gas stream as the latter issues from the container. The liquid remaining in the interior of the container is rapidly chilled and takes the solid or crystallized form as soon as the temperature has been reduced below 75° F. From this solid condition it can be evaporated only by the application of heat.

The CO_2 crystals which appear in the gas stream discharged through a valve from the liquid container are merely the wet and subsequently frozen molecules of the escaping vapor. They may be retained and collected in a handful of cotton waste which is held over the valve nozzle, or in a receptacle arranged to allow the gas to pass through its porous or cellular substance but inclined to retain the solidified crystals.

This instrument may have the form of a Goosmann apparatus, consisting of a perforated cylinder provided

with packing in the shape of linen toweling held between perforated sleeves and slipped over the perforated cylinder; or, it may consist of a larger receptacle of which the walls are made of porous clay, similar to the clay tubes used by Pasteur in the construction of a germ-proof water filter. Any other device similar in construction will likewise retain and collect the CO_2 crystals produced by rapidly evaporating liquid carbon dioxide.

Upon compression carbon dioxide snow takes on the consistency of a hard snow ball, and when compression is continued it becomes translucent and, finally, transparent. In this condition it is very hard, much harder than ice, and will sing in water. However, until the translucent stage of compression has been reached, it is lighter than water and floats upon its surface.

Statement of Corporation Manufacturing Dry Ice

A pamphlet published by the Dry Ice Corporation of America, founders of Dry Ice, in 1925, contains the following statements:

1. Dry ice is solidified carbon dioxide.

2. Evaporates into a clear, dry gas—without any liquid—at a temperature of 110° F..

3. Resembles a cake of well-packed fine snow, harder than water ice and nearly twice as heavy.

4. It is mildly sterilizing in its gaseous condition and a true preservative of food products.

5. May be made from millions of tons of smoke of coal and coke burning plants going up the chimneys.

6. Liquefiable at temperatures below 88° F., and when expanded from liquid to gas changes into the form of snow by its own coldness of expansion.

7. The manufacture in solid blocks of CO_2 has been termed another impossibility, being impractical, costly and, therefore, of no industrial value.

8. It is more than twice as effective as water ice, pound for pound; weighs twice as much per cubic foot, and is the equivalent, as a refrigerant, of four cubic feet of water ice.

9. The cost is only a few cents per pound, hence it can be sold on a competitive basis with water ice for household refrigerators.

10. It is eminently suitable for shipment of perishables, such as ice cream, butter, meat, fish—almost any perishable.

Besides other and numerous incidental advantages are cited.

Analysis of Corporations Statement

We agree and disagree point for point as follows:

1. Admitted that it is solidified carbon dioxide, which is nothing at all new, as has already been explained.

2. It does evaporate, at atmospheric pressures, at a temperature of —110° F.

3. It resembles a very fine white snow, almost as fine as white flour. But in order to be as hard as water ice, or even harder, it must be compressed into a condition of translucence. In this condition it is heavier than water ice.

[fol. 303] 4. It is an excellent preservative and will keep atmospheric air and oxygen out of confined spaces, which it fills with its greater weight as a gas. Its rate of diffusion into the atmosphere is slow.

5. It can be made only from the combustion products of high grade coke that is practically free from sulphur and hydro-carbons. CO_2 gas from inferior coke, and particularly coal, can not be sufficiently deodorized to form an acceptable product.

6. It is liquefiable at any temperature below 88.43° F. and will change from a liquid to a solid by the evaporating expenditure of between 2.7 and 3 pounds of liquid, according to its liquid temperature, per pound of carbon dioxide snow. In other words from 2.7 to 3 pounds of liquid must be evaporated to change one pound of it into the condition of snow, or one pound of liquid will produce in round figures between 0.3 and 0.35 pounds of snow.

7. Carbon dioxide was the first gas to be solidified by Thilorier, in 1835. There is nothing new about it; the process is exceedingly simple and has been one of the

favorite experiments in class and lecture rooms for many years. Physicians and surgeons have used solidified carbon dioxide, as well as liquid air, for various surgical purposes for nearly twenty years!

8. The heat content of one pound of solidified carbon dioxide is 170 B.t.u. That of one pound of water ice is 144 B.t.u., hence the comparative refrigerating value of the two is $170 \div 144 = 1.18$; in other words, 1.18 pounds of water ice equals in cooling effect at its respective temperature, that of one pound of solidified carbon dioxide.

9. The comparative cost on the basis of B.t.u. refrigerating effect between solid carbon dioxide and water ice is, therefore, approximately as follows:

Water ice per pound = .5 cents.
CO_2 ice per pound = 10.0 cents.

hence, water ice = .5 x 1.18 = .59 cents as against up to 30 cents for CO_2 on the basis of 10 cents per pound. This cost is figured on the assumption that the CO_2 is solidified in the refrigerator of the consumer. It may be considerably reduced when furnished in the solid form by liquid CO_2 manufacturers who can produce it on a larger scale as will be further explained. However, the relative and comparative cost under the most favorable conditions will still be 10 times greater than the cost for water ice.

10. When first cost is not an item for consideration, solidified CO_2 may be used for the shipment and delivery of ice cream, butter, frozen meat, fish, or poultry. It appears that for such purposes it may be conveniently employed. However, it is not clear that it can be used for the shipment of unfrozen perishables such as fruit for instance, because of the low temperature of the refrigerant which is at a temperature of 142° F. below the freezing point of water.

Solid CO_2 as a Manufactured Product

It should be apparent, from the foregoing, that the use of solidified carbon dioxide is out of the question, on account of cost, for cooling the household refrigerator.

It is also much too costly for ordinary shipping purposes when manufactured by the shipper through the simple

evaporation of liquid from a container, in which case the evaporated liquid of the chilling process becomes a total loss. Its usefulness at this price can be considered only in very extraordinary shipments, where certain advantages, together with the novelty of the method, compensate for the high cost of CO_2 snow production.

However, the process approaches commercial and industrial possibilities close whenever the CO_2 snow is produced at the factory of the liquid CO_2 manufacturer where the 2.7 to 3 pounds of liquid evaporated in the production of one pound of CO_2 snow may be recovered and turned back into the form of a liquid merely at the expense of compression and liquefaction, which is roughly one-half of the total cost of liquid CO_2 manufacture.

This will become clear immediately upon the consideration that the actual cost of producing liquid CO_2 is roughly one cent per pound. The cost of the expensive shipping containers in which liquid CO_2 is handled in commerce does not enter into this consideration because they are not needed for this purpose, and they can be used on the average only about three or four times per year, frequently not even that often, and cost $19.00 each. Hence, their entire amortization must be charged against the limited quantity of liquid which they deliver to the consumer in a year's time, which, therefore, forms a considerable item in the total expense.

The loss of CO_2 snow between manufacture and delivery to the consumer need not be very great, within practical time limits, because of its slow evaporation from a solid into gas. Its temperature is so low that it immediately envelopes itself with a rarefied gas jacket through which heat transfer becomes exceedingly slow. Stout cartons made of paper board will give it sufficient protection against spilling and avoidable losses by evaporation. It is also possible to use containers for the delivery of CO_2 snow which employ in their construction the principle of the vacuum bottle, in which the heat losses are so slow that the material will shrink but little in many hours.

Actual Cost at the Liquid CO_2 Factory

Assuming a cost price of 1 cent per pound of liquid CO_2 and allowing the evaporation of 2 pounds of liquid out of

3 in the production of one pound of CO_2 snow it results in an obvious expense of 3 cents, from which the value of the recovered and reliquified gas must be deducted. The cost of recovery and reliquefaction will not exceed 0.5 cents per pound. Therefore, 3 cents first cost minus 1 cent actually recovered value, leaves a net total cost of 2 cents per pound of CO_2 snow. Supposing that the shrinkage between manufacture, delivery and use is about 30 per cent, it will increase the cost price per pound of snow actually available for refrigerating work to 2.6 cents per pound. Adding to this other charges as well as profit at roughly 100%, it will be seen that this material may be actually delivered to the consumer or shipper at a total price of approximately 5 cents per pound of CO_2 snow.

It is clear that even this reduced cost price for CO_2 snow does not put it in the line of direct competition with water ice. On a B.t.u. basis of 1.18 pounds water ice per pound of CO_2 snow the ratio of comparative cost is still about 6 cents to 0.5 cents.

On the other hand, the low temperature of CO_2 snow makes it applicable for purposes in which ice drops out of the consideration. Its other advantages, such as reduced weight, bulk, cleanliness, preservative, sanitary, and antibacterial properties advance it into industrial usefulness where its employment may be considered.

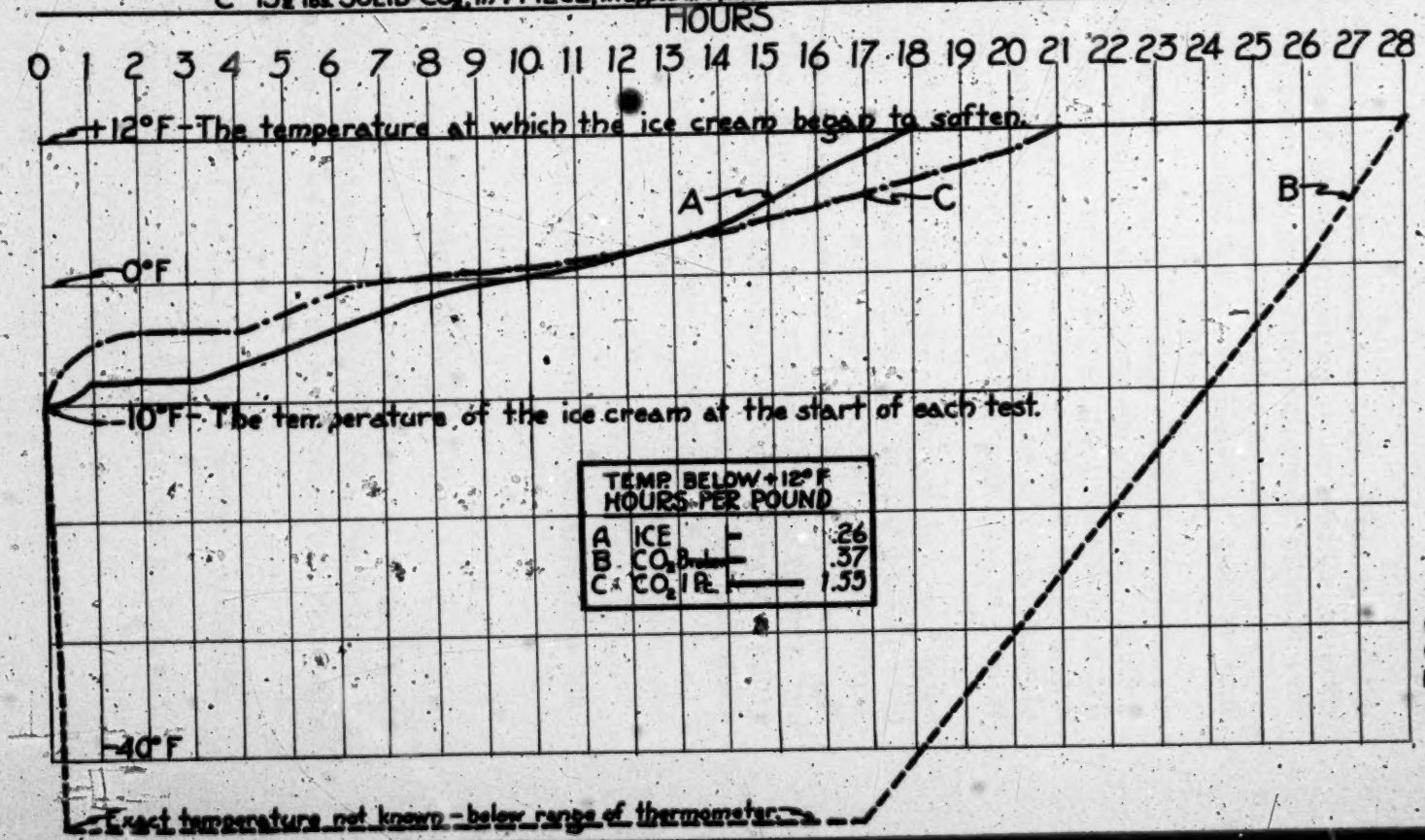
However, all other claims as to enormous refrigerating properties, duration of refrigerating effect and unlimited usefulness must be put down merely as the bombastic statements of over enthusiastic promoters. It can not do more than to employ its latent heat of 170 B.t.u. per pound, plus the temperature of the gas between —110° and +30°, which, on the basis of its specific heat of very closely .25, will yield an additional heat value of 30 B.t.u. per pound, so that its grand total refrigerating heat value can not possibly exceed 205 B.t.u. per pound.

World's Poultry Congress

Poultry scientists and leaders of the poultry industry in every land are looking forward with interest to the World's Poultry Congress, which is to be held at Ottawa,

TEMPERATURE OF ICE CREAM — 5 GALLON CAN IN WOODEN TUB

PACKED WITH: A 70 lbs. ICE & 17½ lbs. salt (4-1), packed around and over ice cream can. Tub uncovered.
B 76 lbs. SOLID CO_2, BROKEN into pieces, packed around and over ice cream can. Tub uncovered.
C 13½ lbs. SOLID CO_2, in 1 PIECE, wrapped in 1 piece of newsprint, placed on top of can. Tub covered, 4 thicknesses newsprint.



PLAINTIFF'S EXHIBIT No. 22

Canada, from July 27 to August 4, 1927. This will be the first international poultry meeting to be held in America and will represent the most thorough-going attempt ever made in any country to get together at one series of sessions the best thought on every phase of poultry husbandry.

These congresses, which are held every three years, are planned to accomplish a dual purpose. To bring together the newer knowledge applicable to the production, distribution, and consumption of poultry products, to the manufacture of poultry appliances and utensils, and also to increase the interest of consumers in a wider use of poultry products.

Every branch of the poultry industry in the United States will be represented at the congress, and it is expected that the Federal and State departments of agriculture, colleges of agriculture, and other institutions will be represented. The American Association of Instructors and Investigators in Poultry Husbandry, the American Poultry Association, are planning to hold their 1927 annual meetings in Ottawa at the *the* time of the congress.

(Here follows Plaintiff's Exhibit No. 22, side folio 304.)

[fol 305] DEFENDANT'S EXHIBIT A

Abstract of File Wrapper and Contents of Slate Patent No. 1,511,306, Granted October 14, 1924, for Method and Apparatus for Refrigerating and Preserving Perishable Products

Application Filed January 10, 1924. Serial No. 685,482.

The original Specification and Claims were as follows:

"Specification

"To all whom it may concern:

"Be it known that I, Thomas B. Slate, a citizen of the United States, residing at New York City, in the county

of New York, and State of New York, have invented a new and useful Method of and Apparatus for Refrigeration and Preserving Perishable Products, of which the following is a specification:

"The object of my invention is to provide a novel method of preserving perishable products by a combination of refrigeration and the preserving qualities of carbon dioxide gas. My invention also includes the method of handling the gas for this and other purposes such as the preserving, handling and shipping bacterial products for medicinal purposes, or the handling and shipping of any product requiring refrigeration or preservation by the exclusion of air where air is displaced by carbon dioxide gas. It is further an object of my invention to make use of carbon [fol. 306] dioxide because of its preserving qualities, and because of the ability of the manufacturer to purify the gas; and to provide a system of handling the gas which also improves the purity of the delivered article for use. It is also an object of my invention to provide a method of and apparatus for refrigerating purposes which prevents mold as well as excluding the air with all its destructive bacterial elements, for carbon dioxide gas absorbs moisture and prevents mold. It is also an object of my invention to provide novel and highly efficient non-complicated apparatus by means of which my refrigerating process may be performed, as shown in the accompanying drawings illustrative of a method of manufacturing and handling the refrigerant and the method of using it. I attain these and other objects of my invention by the mechanism illustrated in the drawings, in which—

Figure 1 is a side elevation, partly in section, of my apparatus for producing carbon dioxide snow;

Fig. 2 is a detail side elevation of the lower end of refrigerator shell 8;

Fig. 3 is a detail sectional view of removable cap 10;

Fig. 4 is a detail side elevation of plug 12;

Fig. 5 is a detail sectional view of resilient ring 13;

Fig. 6 is a longitudinal section view of a chamber such as a refrigerator car with my refrigerator storing apparatus installed;

Fig. 7 is a top plan of same;

Fig. 8 is an enlarged detail sectional view of member 25;
[fol. 307] Fig. 9 is a similar view taken at right angles to Fig. 8;

Fig. 10 is a horizontal section on line 10-10 of Fig. 7;

Fig. 11 is a detail sectional view of member 24 showing the approximate shape required for discharge passage 24';

Fig. 12 is a vertical section, partly in elevation, of a modification including the added elements 28, 29 and 30 for cooling conduit 24;

Fig. 13 is a horizontal section on line 13-13 of Fig. 12;

Fig. 14 is a view of a refrigerating chamber such as a refrigerator car 20, provided with a removable cover or skylight 34;

Fig. 15 is a top plan of same, partly in horizontal section;

Fig. 16 is a perspective view of the snow chamber 22;

Fig. 17 is a perspective view of a suitable cover for same;

Fig. 18 is a vertical section through a shipping case containing food products and a dioxide snow chamber or refrigerator in the center thereof;

Fig. 19 is a vertical section through the dioxide snow chamber 22;

Fig. 20 is a front elevation of a home refrigerator especially designed and adapted for using carbon dioxide snow for refrigeration;

Fig. 21 is a perspective view of the shelf I have designed for such home refrigerator;

Fig. 22 is a vertical section through the refrigerator mentioned; and

[fol. 308] Fig. 23 is a horizontal section on line 23-23 of Fig. 22.

Like characters of reference indicate like parts throughout the several views.

Referring to the accompanying drawings and particularly to Figs. 1 to 5, I provide a conventional tank or container 1 of liquid carbon dioxide 2 under high pressure, the container 1 of being provided with the conventional release valve 3. The element 1 is to be understood as representing any suitable source of supply of liquid carbon dioxide and not merely a particular form of container. Element 1 may, for example, consist of a manufacturing plant by means of which liquid carbon dioxide is produced. Opening out

of valve 3 I provide a pipe 4 in communication with the source of supply 1, leading through valve 5 and discharging through top 7 into a refrigerator shell 8, which at its lower end is provided with a closure plug 12, quick detachable cap 10 and interposed resilient ring 13. Cap 10 and shell 8 are threaded in a similar manner, preferably at spaced portions, permitting of quick application or removal of the cap 10 and plug 12.

I provide a compressor 17, with a suction pipe 15 leading from supply pipe 4 on the discharge side of valve 5, through check valve 16 to compressor 17 and out through check valve 18 and pipe 19 to supply pipe 4 on the supply side of valve 5.

Referring to Figs. 6 to 11, I provide a snow chamber 22 for any chamber 20 to be refrigerated, such as a refrig- [fol. 309] erator car. Snow chamber 22 is supported on a suitable bracket 21 and is provided with a circular dome 23 into which the nozzle 24 opens, said nozzle 24 being connected to pipe 4 and controlled by valve 5'. As shown in Fig. 7, this nozzle 24 opens into dome 25 at one side thereof to cause a whirling movement of the gas and snow discharging from nozzle 24. I also provide a gas discharging pipe 28 having one open end in communication with the interior of snow box 22 and having the other open and extending to and opening into a distant part of chamber 20, as shown in Figs. 6 and 7.

Referring to Fig. 12, I provide a modification of this device for the production of snow to be used for any purpose, the pipe 28 opening into a yoke pipe 29 which in turn opens into the relatively large pipe 30 enclosing pipe or nozzle 24 exterior to the dome 23 for cooling the intake nozzle 24, as shown in Fig. 12, pipe 30 being of sufficient capacity to permit the gas to flow freely around and cool nozzle 24.

As shown in Figs. 6 and 7, the gas discharged through pipe 28 into chamber 20 is used for displacing the air, chilling and removing moisture from the chamber, and its contents. Referring to Figs. 6 and 12, the element 26 represents the carbon dioxide snow formed by the liquid carbon dioxide passing through nozzle 24; and its expansion from high pressure to a gas at atmospheric pressure refrig-

erates one portion (approximately one-half) of its weight to carbon dioxide snow, the other portion going to gas. The snow being heavier than the gas settles to the outside [fol. 310] and bottom of the container by its weight and by centrifugal force. The gas being lighter than the snow, collects in the higher and central portion and is forced to the position shown in the drawings by the whirling movement of the inflowing gas and escapes through discharge pipe 28. This action effects a conical pocket 27 that will build up toward pipe 28 until the chamber 22 is completely filled. My apparatus forms the snow in a compact cylindrical body or brick that may be commercially used for many purposes not specifically mentioned herein.

Referring to Fig. 11 which is an enlarged view of nozzle 24, I provide a reduced passage 24′ approximately of the shape shown, where expansion starts and where the snow is formed.

Referring to Figs. 14 and 15, I provide a modification of the device shown in Figs. 6 and 7, permitting of the snow being manufactured elsewhere and delivered to the chamber to be refrigerated. I provide a suitable removable cover 34 on chamber 20, and a removable cover 31 on snow chamber 22, so that the snow space 26 is readily accessible for filling when needed. As the snow 26 reverts to a gaseous state, the gas may escape from under the lid 31 of chamber 22, or it may be piped in a suitable manner, as shown in Figs. 6 and 7, to any desired part of chamber 20. Fig. 16 shows an enlarged view of chamber 22, and Fig. 17 an enlarged view of cover 31, with a suitable handle 33.

Referring to Fig. 18, I provide a simple means of using the refrigerator box 22 in small shipping containers 20, for [fol. 311] the shipment of small quantities of perishable products 57, which are thus easily and efficiently refrigerated by making snow chamber 22 of the proper size to displace a given number of packages of the perishable products to be shipped and by filling chamber 22 with carbon dioxide snow and placing it in the midst of the shipment of products shipped it will slowly and gradually refrigerate those products by the escaping gas which forces its way under the lid of chamber 22 and continuously keeping the air and moisture displaced.

Referring to Figs. 20 to 23, I provide a home refrigerator 35, having doors 36 provided only in the upper portion thereof, and having a convenient shelf 46, as shown in fig. 21, for separating the upper from the lower part of the refrigerator 35. Members 42 and 43 are slide shelves mounted in the openings 41 and slidably supported on the guides 44, to make the lower compartment of the refrigerator readily accessible through the doors 36. Slide shelves 42 and 43 are provided with apertures 45 for operating the slides as well as for the escape of gas into the upper chamber of the refrigerator. The refrigerator, as shown in detail in Fig. 22, has conventional insulation 37 between the walls of 35; and is provided with suitable shelving 38, 39 and 40. At the bottom of the refrigerator is the cold storage compartment 46 for the storage and preservation of perishable products for indefinite periods. This is effected by making the lower half of the refrigerator airtight to the bottom of doorways 36. The escaping carbon dioxide being heavier than air excludes the air from this compart- [fol. 312] ment and the escaping gas from the carbon dioxide snow being very cold first goes to the lowest part of the chamber 35 and as it becomes warmer it is raised to a higher position by the cold gas continually escaping from the snow. Compartment 47 is provided immediately above compartment 46 and is not quite so cold and not quite as free from atmospheric air, owing to the occasional opening of the refrigerator doors 36, but is sufficiently cool and sufficiently charged with carbon dioxide for shorter periods of cold storage. Compartments 48 and 49 are additional compartments still higher and not quite as cold as compartment 47 and containing more atmospheric air. These compartments are for daily use, and are especially valuable where such foods as butter are kept for daily use; thus the plate of butter 55 on the upper shelf is for daily use, and the package of butter 56 in the lower compartment is for indefinite storage. Other food supplies may be handled in the same manner according to the wishes of the user.

Member 51 represents a "thermos" bottle or like vacuum for insulation purposes instead of insulation as represented by elements 20 and 22, which are wood insulation, such as

balsa wood. The vacuum-walled chamber type of insulation illustrated in Fig. 22 may, if found desirable, be used as an equivalent to and in place of the balsa wood or similar insulation 22 shown in Figs. 18 and 19 and in previous figures of the drawings, even in railroad cars or large chambers of any dimensions for insulation of the carbon dioxide [fol. 313] snow. Vacuum chamber 51 is provided with a suitable lid or cover 51, having a spaced wall 53 and a cover handle, 54 and also having a passage 54 for the escape of gas through the lid or cover, instead of under its edges as described and illustrated in connection with other figures of the drawings. This escape gas passage 54 may however be applied to any of the previously described boxes or containers of carbon dioxide snow, if preferred, and if desired the inner end of pipe 28 might be placed in communication with passage 54.

To operate my invention, particular reference being had to Figs. 1 to 5 inclusive, compressor 17 is started and valve 5 opened. This allows a complete circuit through suction pipe 15, check valve 16, compressor 17, check valve 18, discharge pipe 19 and through valve 5 back to pipe 15. The valve 3 is then opened allowing the pressure of liquid carbon dioxide from the source of supply 1 to cause the gas to flow through pipe 4 into refrigerator chamber 8. When the pressure gauge 6 registers a pressure that would indicate liquid in chamber 8 at the temperature of the chamber, the valve 5 is closed. The closing of valve 5 starts the compressor to pumping from chamber 8 back to the source of supply, through pipe 15, check valve 16, compressor 17, check valve 18 and pipe 19 to pipe 4 on the supply side, which is cut off from chamber 8 by means of valve 5. As soon as the gauge 6 registers no pressure, the liquid carbon dioxide in chamber 8 has vaporized until the latent heat of vaporization has turned a portion of the [fol. 314] liquid to ice or snow. As it turns to snow, the pressure may be completely taken off and it will remain a solid to be handled and used as the operator may choose.

The snow as it thus comes from the device is porous and light, but is then compressed by any suitable apparatus into bricks of any convenient size to fit the requirements of the trade. These bricks may be easily compressed to a considerably greater density than the liquid carbon diox-

ide, or even greater than water ice or water itself, making it especially valuably for carbonating purposes because the brick of ice when placed in water will immediately go to the bottom so that the escaping gas as it melts bubbles up through the water to be absorbed according to the pressure of the water. The compressed brick of carbon dioxide snow also occupies smaller space and facilitates insulation very considerably by reason of its reduction in size, and not being porous it is required to evaporate wholly from its exterior surface, while the porous snow may evaporate through its pores, and offers a far greater surface for evaporation.

The carbon dioxide snow when compressed has the appearance of and a greater density than ice. Throughout the specification and claims the terms "carbon dioxide snow" or "snow" are to be construed as referring to the product whether in its porous or in its compressed form.

When the gauge registers no pressure, the cap 10 on chamber 9 may be easily turned to the left until the threaded portions 11 disengage each other through the vacant spaces and the cap readily and quickly slipped off, [fol. 315] allowing the contents of chamber 8 to fall into any convenient receptacle. Cap 10 is then replaced by pushing it back to position and turning it to the right until the threaded portions 11 properly engaged each other. Then the valve 5 is again opened and the chamber 8 allowed to refill as before. After a few operations, the chamber 8 will become very cold and will fill with liquid very rapidly at a reasonably low pressure and a very considerable proportion of the liquid at this low temperature will turn to snow in each operation.

Another form of snow making device is shown in Figs. 6 to 13 inclusive, this type being especially adapted to charging refrigerators of considerable capacity, the snow device being installed in the refrigerator as a part thereof. The snow device operates by connecting pipe 4 of Fig. 6 to pipe 4 on the supply side of Fig. 1. The valve 5′ in pipe 4 is opened, allowing the liquid carbon dioxide to flow through the nozzle 24 and expand at 24′ as shown in Fig. 11. This sudden expansion of the liquid causes a part of it to turn to snow and the other part to gas. The force of the escaping snow and gas in one side of the snow dome or cylindrical chamber 25 causes a whirling effect of the

snow and gas which acts to separate them, the centrifugal force and the weight of the snow causing it to travel to the outer portion of the cylinder and settle, and the same force causing the gas to move to the inside and upper position. This action will fill the chamber 22 with snow as shown at 26, without any snow escaping through dis- [fol. 316] charge pipe 28 until the chamber 22 has completely filled. The portion of the liquid that turns to gas leaves the chamber 22 through pipe 28 at a very low temperature and is, as illustrated in Figs. 6 and 7, used to displace the remaining atmospheric air and moisture from the loaded car or chamber 20 after it has been completely loaded and closed up ready for refrigeration and transportation. The chamber 20 needs to be airtight or as nearly so as is practicable to make it, to the top of its side walls, as well as at the doorways, if they are provided in the side of the car as illustrated. This being done, the refrigerator car may be charged by merely connecting a source of supply of liquid carbon dioxide to the pipe 4 and opening the valve, permitting it to flow through nozzle 24, filling chamber 22 with snow, and discharging cold gas through the discharge pipe 28 to the point indicated by 29 in Fig. 6, this cold gas immediately settling to the bottom of the car and filling the car, displacing air to the top of the car or chamber 20, and cooling the contents of the car, refrigerating and preserving its contents for any predetermined length of time required for shipment.

When the container 22 has been filled with carbon dioxide snow the pipe 4 is disconnected and the valve 5 is closed. The walls of the chamber 20 and of chamber 22 both are insulated, the latter insulation being necessary to prevent the over-refrigeration of the contents of chamber 20 at points nearest to chamber 22, as well as to preserve the [fol. 317] carbon dioxide snow for a considerable length of time by retarding its reversion to a gaseous state. It will be understood why this is necessary inasmuch as the temperature of the carbon dioxide snow is approximately between 108 and 112 degrees below zero Fahrenheit. The amount of insulation for chamber 22 is varied according to the amount of refrigeration required. As the temperature of the contents of chamber 20 rises the rapidity of evaporation of snow 26 in chamber 22 increases. The gas

evaporating from the carbon dioxide snow leaves at a temperature of approximately 108 degrees below zero Fahrenheit, and as it passes out through pipe 28 along the upper part of chamber 20 to its other extreme end, it absorbs the heat, rises to the top of the chamber and then is discharged at 29 to settle to the bottom of the car as cold gas, displacing the warmer gas and any atmospheric air or moisture that might be left in chamber 20.

The above described method of making the carbon dioxide snow may be used for making snow for other purposes by applying a removable chamber to dome 23, as illustrated in Fig. 12, and when filled this removable dome 22, shown in Fig. 12, may be taken off and emptied and replaced for refilling. In this instance, where I do not need the escaping gas from this device for other purposes, it may be first passed from pipe 28 to a yoke pipe 29, and thence to large pipe 30 surrounding the liquid supply pipe 24 and 4, as shown in Fig. 12, whereby to lower the temperature of the liquid carbon dioxide entering the converting chamber, and causing a greater portion of the carbon [fol. 318] dioxide to turn to snow at passage 24; pipe 30 may then lead to pipe 15 of the compressor and be compressed back to the supply line 4, thereby saving gas escaping from the snow or converting device, as in the apparatus illustrated in Fig. 1.

In Fig. 14 is illustrated a method of using manufactured carbon dioxide snow by simply depositing it in a chamber 22 through covers 34 and 31, and using the escaping gas as it vaporizes from the snow to refrigerate chamber 20, as in the case of Figs. 6 and 7. The gas may be permitted to escape from under cover 31 or may be piped as in the case of the devices illustrated in Figs. 6 and 7, to any desired place in the refrigerator chamber 20. Any combination or rearrangement of the devices illustrated may be alternatively used, such as using refrigerator chamber 8 in place of chamber 22 in Figs. 6 and 7 by using a pipe 15 to discharge the pressure from chamber 8, in the same manner as pipe 28 is used in Figs. 6 and 7, and placing a suitable valve in pipe 15 similar to valve 5', through which to release the pressure, instead of pumping it by means of compressor 17.

A simple method of charging small shipments of perishable products with carbon dioxide is shown in Figs. 18 and

19. Member 20 illustrates a wooden box or any well-insulated shipping container, made airtight to any point near the top of said box or container. The smaller box or chamber 22 is of similar or suitable structure of good insulating material and of a size to displace a given number of pack- [fol. 319] ages or parcels of the product 57 to be shipped and which must be preserved during shipment, the box or chamber 22 being filled with carbon dioxide snow and packed at or near the center of the shipment of articles to be preserved. There will be an automatic regulation of the temperature of the contents of chamber 20, for as the temperature rises the rapidity of escaping cold gas increases. The preserving qualities of carbon dioxide are likewise utilized, as the box will fill up with carbon dioxide, displacing any air and moisture that might be in the box 20.

In my home refrigerator for using this form of refrigeration, shown in Figs. 22-23, box 35 is made airtight, at least downward from the doorways 36, which are necessarily in the upper part of the refrigerator only. In this type of refrigerator I utilize a "thermos" bottle type of container for the carbon dioxide snow; and may use this particular type of container if found preferable throughout all the various uses of the carbon dioxide snow as a refrigerant, to get a more complete insulation of the snow from the perishable products or supplies to be preserved, and also for the purpose of increasing the length of time a given amount of the snow will ordinarily supply cold carbon dioxide gas as a preservative and refrigerant to any refrigerating chamber. In chamber 51 I provide a lid or cover 52 with a passage 54 for the escape of gas, which form of cover may also be used throughout the other devices if desired, or connected with pipe 28, or in any similar manner. In this type of home refrigerator, which [fol. 320] may also be used for hotels, restaurants, or other places where refrigerators are used for the preservation of food supplies, I provide varying temperatures in different parts of the refrigerator, as well as a variable density of carbon dioxide gas, by placing the refrigerant, carbon dioxide snow, at or near the bottom of the refrigerator, and as the cold gas escapes from this container 51 it immediately settles to the bottom of the refrigerating chamber 46 and drives any air there may be and the warmer gases upward, effecting a complete filling of the

compartment with carbon dioxide gas. The lower compartment 46 is used as a cold storage compartment for the indefinite preservation of any perishable products. The compartment 47 immediately above is not quite so cold, and the higher compartment 48 is warmer. The doorways 36 opening into the upper compartments 48 and 49 admit a certain amount of atmospheric air, and these compartments will be used for preservation of products in daily use. An illustration is that of the dish of butter 55 on an upper shelf where it will not be too cold and become solid or frozen so as to prevent convenient spreading. The carbon dioxide snow is insulated as completely as is convenient from the warmer temperatures of the outside atmosphere and the very cold carbon dioxide gas produced by the evaporation of the snow is used for preserving products requiring the greatest amount of refrigeration.

It is quite commonly known that carbon dioxide has great preserving qualities, as it is one of the most inert [fol. 321] gases known and being absolutely free of all bacteria and other elements causing deterioration of all perishable products, it causes them when completely immersed in the pure gas to maintain their present state of preservation for a very considerable length of time, and any product that has its pores completely filled with carbon dioxide gas will be preserved from decay practically regardless of temperature, so that a combination of slight refrigeration and complete exclusion of atmospheric air will preserve perishable products longer and more completely than any other type of refrigeration. Pure carbon dioxide gas has an affinity for moisture also that will prevent mold and other damaging effects caused by moisture. This fact is especially valuable in shipping grapes and other small fruits that mould very easily from the moisture of ordinary water-ice refrigeration.

Another important factor of this method of refrigeration is the possibility of keeping the refrigerant absolutely sanitary by turning it to ice directly from the source of supply instead of storing it in metal containers that corrode and rust quite badly, contaminating the liquid stored therein as in the case of the conventional carbon dioxide metal tanks.

A further important value of carbon dioxide snow as a refrigerant for shipping as well as for home refrigeration

is the fact that it supplies a great volume of the combination of refrigerant and preservative from a very few pounds of carbon dioxide snow. This is valuable in shipping because of the small space occupied by the refrigerant, and [fol. 322] its light weight. It is especially valuable for home refrigeration because of the superior convenience and small cost of handling and delivery of the refrigerant, as it is light, dry, and clean, and being so it may not only be conveniently handled, but a refrigerator containing it may be placed anywhere in a kitchen or dining room to suit the wishes of the user, without any installation of plumbing being necessary to connect it to sewerage, as in the case of water-ice refrigerant, nor is there any need for drip pans of any kind, which pans are oftentimes neglected and allowed to run over when water-ice is used.

What I claim is:

1. A method of and apparatus for making carbon dioxide snow by conducting liquid carbon dioxide into a closed chamber in which it is permitted to suddenly expand, and withdrawing the free gas to the source of supply for a repetition of the process.

2. In a method of and apparatus for making carbon dioxide snow, the process of conducting liquid carbon dioxide to a closed chamber, said chamber being protected from the atmosphere by insulation to permit of refrigeration under a reasonably low pressure, the liquid carbon dioxide being permitted to suddenly expand in said chamber and the free gas being continuously withdrawn and the process repeated until the chamber is filled with carbon dioxide snow to the extent desired.

[fol. 323] 3. In combination with the apparatus described in claim 2 and using the method therein defined, means for applying the low temperature of the previous refrigeration to the next one following to liquify the gas at low temperature.

4. In an apparatus for carrying out the method of producing carbon dioxide snow described, means for supplying liquid carbon dioxide to a closed insulated chamber in which it is allowed to suddenly expand, means including a compressor for returning the escaping carbon dioxide gas to the source of supply, the return of the gas being con-

trolled by the operation of a single valve included in the aforesaid means.

5. In a method for producing carbon dioxide snow, the process of releasing liquid carbon dioxide in a closed chamber where it may expand rapidly, said liquid carbon dioxide being delivered into the closed chamber tangentially thereof and thereby effecting a whirling action of the snow and escaping gas, whereby to separate the snow from the gas by a combination of centrifugal force and gravity.

6. An apparatus for producing carbon dioxide snow, comprising a closed insulated cylindrical chamber, a conduit opening into said chamber and terminating in a restricted passage for the sudden expansion of the liquid carbon dioxide, a source of supply of liquid carbon dioxide under high pressure, a discharge pipe for the escaping carbon dioxide not converted into carbon dioxide snow, where- [fol. 324] by said escaping carbon dioxide gas may be utilized for other valuable purposes during the process of producing a refrigerant of the type described.

7. In combination with the apparatus described in claim 6, said discharge pipe being of sufficient capacity and arranged to inclose the nozzle or pipe through which the liquid carbon dioxide is delivered to the converting chamber where the carbon dioxide snow is produced, whereby the escaping gas is utilized to lower the temperature of the inflowing liquid carbon dioxide and permit of operation of the apparatus under a lower pressure of the liquid carbon dioxide.

8. In combination with an apparatus for making carbon dioxide snow by the method described, means for separating the snow from the escaping gas by a combination of centrifugal force and gravity, and means for conducting said escaping gas to desired portions of a chamber to be refrigerated such as refrigerator car to displace air and moisture from the chamber and no other temperature of the chamber at the same time for efficiently preserving perishable products.

9. A refrigerating system wherein carbon dioxide snow is used as the refrigerant, said system including a containing chamber sufficiently insulated to prevent over-refrigeration and to preserve the snow and extend the

period of refrigeration to a point where it is commercially useful.

[fol. 325] 10. A system of reducing the temperature of refrigerating chambers wherein carbon dioxide snow is produced and used as the refrigerant, said system including means for insulating the refrigerant to the extent required, substantially as set forth.

11. In a refrigerating system, means for containing carbon dioxide snow, said means including a sufficient extent of insulation to preserve the snow for extended refrigeration and to prevent over-refrigeration of the products to be refrigerated, and means for using the melting carbon dioxide snow both as a refrigerant and as a preservative by utilizing the escaping gas to prevent deterioration of perishable products.

12. In a refrigerating system, the combination of a chamber to be refrigerated, a container of carbon dioxide snow, said container being formed of or including insulating means, the capacity of the container being suitably proportioned to the total capacity of the chamber to be refrigerated to effect the required refrigeration by the escaping carbon dioxide gas produced by the evaporation of the carbon dioxide snow within the aforesaid container.

13. A refrigerating system using carbon dioxide snow as a refrigerant, said system including a chamber to be refrigerated, a vacuum insulated container within said chamber, said container being of suitable size to contain the desired quantity of carbon dioxide snow and being adapted to pre-
[fol. 326] vent rapid melting of the aforesaid snow.

14. A refrigerating system adapted to and using carbon dioxide snow as the refrigerant, said system including a chamber to be refrigerated, a substantially closed insulated chamber to hold the carbon dioxide snow and adapted to produce the desired refrigeration by the cold carbon dioxide gas resulting from the evaporation or melting of the snow, the specific gravity of the gas being utilized to exclude air and moisture from the chamber or portion thereof in which are placed the products to be refrigerated.

15. A refrigeration apparatus adapted for and using carbon dioxide snow as the refrigerant, said apparatus comprising a refrigerating chamber, said chamber having doors only in its upper portion and having its lower portion airtight, shelves in said refrigerating chamber, said shelves having sliding doors whereby to afford access to the lower compartments of the chamber through the upper doors thereof, and a container of carbon dioxide snow positioned in or near the bottom of the refrigerating chamber, whereby the user is afforded compartments of different refrigerating temperatures and whereby the chambers most frequently in use are the more accessible, said regulation of the temperatures of the respective compartments is automatically controlled by the density and purity of the escaping carbon dioxide gas from the container of carbon dioxide snow in the bottom compartment, substantially as set forth.

[fol. 327] 16. A refrigeration apparatus adapted for and using carbon dioxide snow as the refrigerant, said apparatus comprising an insulated refrigerating chamber, said chamber having its lower portion substantially airtight, doors only in the upper portion of the chamber, an insulated container of carbon dioxide snow positioned in or near the bottom of the refrigerating chamber, whereby the temperatures of different portions of the refrigerating chamber are automatically controlled by the density and purity of the carbon dioxide gas escaping from the insulated container of the carbon dioxide snow at the bottom of the refrigerating chamber.

17. In apparatus of the class described, the combination of a source of supply of liquid carbon dioxide, an insulated container, a conduit extending from the source of supply of liquid carbon dioxide to the insulated container, a compressor, a conduit communicating between the first named conduit and the compressor and affording a passage to the compressor, a conduit extending from the compressor to the first named conduit, check valves in each of said conduits, a valve in the first named conduit positioned at a point in the conduit between the juncture of the second and third conduits with the first named conduit.

18. In combination with the apparatus described in claim 17, the insulated container having an open end, and detachable closure means for the open end of said container.

[fol. 328] 19. In combination with the apparatus described in claim 17, the insulated container having an open end, said end having spaced threaded portions, a cap having correspondingly threaded portions correspondingly spaced to permit of quick removal and replacement on the end of the insulated container, a plug slidably seatable in the open end of the insulated container, and a resilient ring interposed between the plug and the cap member for effecting an airtight joint when pressure is exerted on the plug from within the insulated container.

20. In apparatus of the class described, an insulated container open at one end thereof, said container having its open end provided with spaced threaded portions, a cap having corresponding spaced threaded portions adapted for quick removal and replacement on the open end of the insulated container, a plug slidably seated within the open end of said container, and a rubber ring interposed between the plug and the cap to effect an airtight joint when pressure is exerted on the plug from within the container.

21. A refrigerant consisting of carbon dioxide snow compressed into a dense mass to prevent rapid evaporation through its pores and to facilitate handling.

22. A method of producing a refrigerant, consisting in conducting liquid carbon dioxide into a chamber where it is allowed to expand rapidly, collecting the snow resulting from the reduction in temperature of the liquid in reverting to a gaseous state, and compressing the snow thus collected [fol. 329] into a dense mass to prevent its rapid evaporation and to facilitate handling.

23. The process of converting carbon dioxide into snow, and compressing the carbon dioxide snow into cubes or cylinders of great density to facilitate the handling thereof and to decrease the rapidity of evaporation by decreasing the exposed surface.

Thomas B. Slate.

Paper No. 2

Petition, January 26, 1924

Your petitioner respectfully requests that the application of Thomas B. Slate, for Method of and Apparatus for Refrigeration and Preserving Perishable Products, filed Jan-

uary 10, 1924, be given preference over other cases under the last paragraph of Rule 63, in view of the facts set forth in the affidavit of Walter S. Josephson, Vice President of B. M. J. Utilities, Inc., accompanying this petition.

Affidavit, January 26, 1924

Honorable Commissioner of Patents, Patent Office, Washington, District of Columbia.

DEAR SIR: The exclusive manufacturing and sales rights for the invention covered by the Patent Application of [fol. 330] Thomas B. Slate, Serial No. 685,482, filed January 10th, 1924, for a Method of and Apparatus for Refrigeration and Preserving Perishable Products, have been acquired by the B. M. J. Utilities, Inc., a corporation of New York.

We have acquired very considerable factory space and equipment and hold it for the production of the articles covered by this patent, and will provide all of the capital and facilities necessary for placing it on the market on a large scale immediately on receiving favorable action on the patents from the Patent Office.

We are unable to commence operations on a large and practical scale until we receive a favorable action from the Patent Office on the above-named applications for Letters Patent.

Respectfully yours, B. M. J. Utilities, Inc. Walter S. Josephson, Vice-President.

COUNTY OF NEW YORK,
State of New York, ss:

Sworn to before me this 24th day of January, 1924.
E. Robbins Lawrence, Notary Public.

Paper No. 3

Office Action, January 31, 1924

The petition to make this case special has been considered.

[fol. 331] The examiner is authorized to make this case special if he can do so without prejudice to any possible

interfering applications. However, if the application should be rejected, the examiner thereafter will consider the case special only in the event that the applicant makes a bona fide effort to promptly place the application in condition for allowance.

Paper No. 4

Rejection, February 8, 1924

References:

Muller, 891,560, June 23, 1908 (62-92).
Elworthy, 579,866, Mar. 30, 1897 (62-121).
Derby, 735,954, Aug. 11, 1903 (177-73).
Sharpe, 1,449,629, Mar. 27, 1923 (220-61).
German, Heylandt, 193,116, Apr. 27, 1906 (62-92) 1 sht.
French, Crepin, 333,181, June 17, 1903 (62-92) 1 sht.

1. Applicant has stated in his oath that he is a resident of Corona, N. Y., and in his petition and preamble that he is a resident of New York City, N. Y. Uniformity in this respect is required.

2. Page 5, line 20, "46" should be 40.

3. The device shown in Fig. 1 is inoperative as described. As shown only gas could pass from the container 1 to the container 8. The gas could not attain a liquefying pressure in container 8 and no means is shown for taking sufficient heat out of the gas in container 8 to liquefy it therein. Hence there would be no liquid in chamber 8 to be evap-
[fol. 332] orated to make snow from the remaining liquid.

4. Page 7, the first paragraph is incorrect in that it states that the gage 6 would register a pressure that would indicate liquid in chamber 8. This would never occur. See paragraph 3. Furthermore the gage 6 could never register "no pressure" as stated if any carbon dioxide remained in the chamber 8 whether in the solid, liquid or gaseous form.

5. It is required that a full and complete explanation of how the carbon dioxide snow is compressed to a greater density than liquid carbon dioxide and that it is further required that the statement be substantiated, that the result-

ing carbon dioxide has greater density than ice, water or liquid carbon dioxide.

6. The device shown in Figs. 6 to 13 is inoperative for the reason that the container 1 (Fig. 1) as shown, could not supply liquid to the pipe 4 but would only supply gas thereto.

7. The purpose of returning the gas to the supply tank 1 as described on page 10, line 22 is not apparent. No means is disclosed to condense this gas and unless it is liquefied it is not available for refrigeration.

8. Claims 1, 2 and 3 are rejected as indefinite in that they purport to be at once method and apparatus claims.

[fol. 333] 9. Claims 1, 2, 3, 8, 17, 18, 21, 22 and 23 are rejected for lack of novelty and invention in view of the Elworthy patent.

10. Claims 4, 6, 7, 9, 10 and 11 are rejected as indefinite in that they are functional, do not recite sufficient structure to warrant the functional statements therein and for the reason that the cooperative relations of the elements are not brought out therein.

11. As understood, claims 4, 6, 7, 9, 10 and 11 are further rejected on the Elworthy patent.

12. Claim 5 is rejected as indefinite. Although it purports to be a process claim, it recites the single step of "releasing" shown to be old by the Elworthy patent, upon which the claim is further rejected.

13. Claim 5 is rejected on the patent to Elworthy for the reason that it would not involve invention to substitute the Derby means for separation for the means shown on the Elworthy patent.

14. Claims 12, 13 and 14 are rejected on the Heylandt patent for the reason that it would not involve invention to substitute carbon dioxide snow for the liquid air as a refrigerant, in view of the Elworthy patent.

15. Claim 15 is drawn to a device not disclosed. Only a single shelf is shown having sliding doors, whereas the claim recites all of the shelves having sliding doors.

[fol. 334] 16. Claims 15 and 16 are rejected as indefinite and functional and for not reciting sufficient structure to warrant the functional statements therein.

17. Claim 16 is rejected on the Muller patent for the reason that it would not involve invention to substitute carbon dioxide snow for the liquid carbon dioxide in view of the Elworthy patent.

18. Claims 19 and 20 are drawn to an inoperative detail and are rejected. As shown, no abutment is provided for the closure 12 hence the gasket 13 could not be compressed to make a tight joint.

19. Claims 19 and 20 are further rejected on the Elworthy patent for the reason that it would not involve invention to provide the member f with a closure of the type shown on the Sharpe patent.

20. Claims 19 and 20 are further rejected for lack of combination between the specific form of the closure which is of general application and the elements of the refrigerating apparatus.

21. Attention is directed to the fact that the claims apparently cover a plurality of alleged inventions including more than one specific form. If applicant persists in the presentation of claims which are not readable on a single modification, division will be required.

[fol. 335] 22. In view of the art cited and the indefiniteness of the claims, applicant should greatly reduce the claims in number and couch them in the clear and concise terms required by the Statutes, that an issue may be promptly reached.

Paper No. 5

Amendment, February 19, 1924

In response to action of February 8, 1924.

A new oath setting forth applicant's residence as New York City instead of Corona, N. Y., is transmitted herewith.

Correct the drawings, Fig. 1, as shown in red ink in the accompanying print, to illustrate the siphon tube used in

the particular conventional container of carbon dioxide illustrated in this view.

Page 1, line 9, after "and" insert *permeation by carbon dioxide or other suitable inert gas;* same line, after "gas" insert *being especially valuable;* line 14, at the end of the line insert *or other suitable;* last line of the page, after "illustrated" insert *in preferred form, and as applied to the utilization of carbon dioxide.*

Page 2, cancel lines 1 and 2 and substitute: *Fig. 1 is a diagrammatic view, partly in elevation and partly in section, of my apparatus for producing carbon dioxide snow.*

Page 3, line 26, after "circular dome" insert *on converting chamber.*

Page 4, line 10, cancel the superfluous comma after [fol. 336] "chamber"; line 12, insert a semicolon after "nozzle 24"; line 17, after "container" cancel "by its weight and by centrifugal force" and substitute *by centrifugal force and gravity;* line 14, after "approximately" cancel "one-half" and substitute *one-third.*

Page 5, line 16, before "the" change "keeping" to *keeps;* line 20, after "shelf" change "46" to *40.*

Page 6, line 27, change "51" to *52;* line 30, after "this" change "escape" to *escaping.*

Page 7, line 7, at the begining of the line, cancel "gas" and substitute *liquid carbon dioxide;* line 14, before "pressure" cancel "no" and substitute *atmospheric;* line 13, after "valve 5" insert: *The operation above described is repeated and the walls of chamber 8 become so cold from the previous filling and refrigeration that any gas that may enter the chamber is liquefied;* line 30, insert a semicolon after "size."

Page 8, line 9, after "cap" insert *is.*

Page 10, line 3, after "approximately" change "108" to *80;* line 6, after "heat" cancel "rises to the top of the chamber" as superfluous; line 12, after "dome" insert *or converting chamber;* line 13, after "removable" cancel "dome" and substitute *chamber;* line 19, after "chamber" insert *23;* line 20, after "and" cancel "causing" and substitute *to cause.*

Page 11, line 16, insert a period after "preserved" and capitalize "there".

Page 13, line 17, after "from" cancel "the" and substi-

tute *such a;* same line, after "supply" insert *as manufacturing plants.*

Cancel claims 1 to 7, inclusive, and substitute the following:

[fol. 337] 1. A method of making carbon dioxide snow, consisting in conducting liquid carbon dioxide into a closed pressure chamber, withdrawing the free gas therefrom to reduce the pressure in said chamber, and returning said free gas to the source of supply for a repetition of the operation.

3. A method of making carbon dioxide snow, consisting in conducting liquid carbon dioxide into a closed pressure chamber without reduction of pressure and withdrawing the free gas from said chamber and thereby reducing the pressure to make carbon dioxide snow.

4. In a method of making carbon dioxide snow, the process of conducting liquid carbon dioxide into a closed pressure chamber without reduction of pressure, withdrawing the free gas from said chamber and reducing the pressure to make carbon dioxide snow, and successively repeating the aforesaid steps thus applying the low temperature of each previous refrigeration to the succeeding refrigeration to cause the carbon dioxide to remain liquid at low pressure.

5. In an apparatus for making carbon dioxide snow, the combination of a closed pressure chamber, means for supplying liquid carbon dioxide to said closed chamber, and means for reducing the pressure in said chamber and withdrawing the free gas therefrom while retaining the snow in the closed chamber.

[fol. 338] 6. In an apparatus for making carbon dioxide snow, the combination of a closed pressure chamber, means for filling said chamber with liquid carbon dioxide, valve-controlled means for the release of pressure by withdrawing free gas from said chamber, and a compressor in operative communication with the last-named means to return the gas to the source of supply.

7. A method for producing carbon dioxide snow, consisting in releasing liquid carbon dioxide in a closed cham-

ber, and separating the carbon dioxide snow from the gas by the operation of both centrifugal force and gravity.

Reconsider claim 8. This claim defines means for separating the snow from the escaping gas by the operation of both centrifugal force and gravity. The device of Elworthy depends wholly on gravity and is not shaped or adapted to utilize centrifugal force, nor does Elworthy have a central outlet pipe arranged to receive only the lighter element caused to centralize by centrifugal force as does applicant's device.

Cancel claims 9 and 10 as functional and insert:

9. An apparatus for producing carbon dioxide snow, comprising a closed insulated cylindrical converting chamber, a conduit opening into said chamber and terminating in a restricted passage for the expansion of the liquid carbon dioxide, a source of supply of liquid carbon dioxide under high pressure with which said conduit communi- [fol. 339] cates, and a discharge conduit for the escape of gas not converted into snow and permitting of the utilization of said escaping carbon dioxide gas for other useful purposes.

10. The method of refrigeration which consists in placing in a chamber with the material to be refrigerated a suitably insulated solidified mass of an inert substance which at ordinary temperatures and pressures is a gas heavier than air, and which on absorption of heat passes directly from the solid to the gaseous state and permitting the gas as formed to permeate the chamber, displacing the air.

Amend claim 11, line 5, after "means" cancel "for using" and substitute *permitting escape of the gas from;* same line, after "snow" insert *for use.* Reconsider this claim as amended.

Reconsider claim 12. The Heylandt device cited relates to a machine using liquid air. If his device were turned on its side or upside down or jostled around in transit the liquid air would escape through the conduits shown. Heylandt does not show a package or parcel of refrigerant sufficiently and properly insulated from a shipment of perishable products, such as is shown in applicant's Fig. 18, in

which the refrigerant is packed in with the perishable products and capable of effecting controlled refrigeration of those products. Applicant's refrigerant also has inherent preservative qualities, as pointed out in his specification, that make it a substantial improvement over the liquid air [fol. 340] of Heylandt's device, even were the two mechanisms similar, which is not the case.

Cancel claim 13, as not involving a patentable difference over the subject matter of claim 16.

Claim 14, line 3, after "insulated" cancel "chamber" and substitute *container* for the sake of clearness. Reconsideration of this claim is requested for the same reasons as stated above with reference to claim 12.

Claim 15, line 5, before "said shelves" insert *the lowermost of;* line 12, before "automatically" cancel "is" and substitute *being;* line 13, at the beginning of line, cancel "and purity" as superflous. The claim as amended covers a device fully disclosed in Figs. 22 and 23 of the drawings.

Claim 16, line 8, after "density" cancel "and purity" as superflous. Muller cited, shows an insulating refrigerating chamber, it lacks the element of "an insulated container of carbon dioxide snow" etc., called for by applicant's claim 16. The combination recited in this claim is not seen to be met by Muller. It is noted that Muller has a lid or cover but no doors. It is a device for cooling and carbonating liquids or semi-liquids, and is not adapted to be used for the storage of carbon dioxide ice or snow. Reconsideration is requested.

Reconsider claims 17 and 18. Elworthy cited, expands the gas in a tube or coil *r* outside the tank *t* (See Fig. 3 of Elworthy), absorbing heat through a liquid medium from the walls of the tank to freeze carbon dioxide within the tank. This is not the operation of applicant's device, not [fol. 341] the mechanism making up his machine. Elworthy shows no mechanism or arrangement by which liquid carbon dioxide may be gradually and freely admitted to a closed chamber. Nor does he provide a closed chamber with a sealing device of sufficient strength to carry the full pressure of the liquid carbon dioxide, nor provide for drawing off sufficient gas from such a closed chamber to refrigerate or turn to a solid the remaining portion of

the carbon dioxide. The device shown by Elworthy would soon become inoperative, the pipe 12 of Elworthy clogging with solid carbon dioxide. This clogging would occur back in the pipe to a point where the pressure was reduced sufficiently to allow the liquid to vaporize. The foregoing statements are pertinent also as to other claims against which Elworthy has been cited. Allowance of claims 17 and 18 is thought merited.

The operativeness of the closure plug defined in claims 19 and 20 was demonstrated at the interview had with the Examiner, February 15, 1925. No abutement is necessary for the plug as the pressure of the gas within the chamber causes the compression of rubber ring 13 and effects a tight seal. The Sharpe device, cited, is not the equivalent of applicant's plug, it would not withstand the high pressure of carbon dioxide in chamber 8. An automatic seal is effected by applicant's device in combination with his particular apparatus, this is not true of the Sharpe device, which depends on the abutement of a bead of the cap against an exterior annular flange of the Sharpe container, [fol. 342] and which arrangement would not withstand high pressure exerted from within the container. Applicant's specific seal is especially adapted for use with his refrigeration machine in that it is capable of withstanding high pressure from within the refrigerating chamber, effects a tight seal, and permits of quick removal and replacement. Reconsideraiton and allowance of claims 19 and 20 is therefore requested.

Cancel claims 21-23 inclusive and renumber claims 14, 15, 16, 17, 18, 19 and 20 to 13, 14, 15, 16, 17, 18 and 19, respectively.

In view of the interview had with the Examiner on February 15, 1924, when a demonstration of operativeness of the invention was made, and of the rewriting of certain claims objected to, favorable reconsideration of the application is believed to be merited. Action on the matter of division is deferred pending a definite requirement and statement as to claims to be divided.

Paper No. 6

Rejection, February 8, 1924.

In response to the amendment filed Feb. 18, 1924.

Additional references:

British, Hall, 10,378, Apr. 28, 1910 (62-121), 1 sht.
French, Naturel, 514,037, Oct. 23, 1919 (62-121), 1 sht.
Moore, 281,387, July 17, 1883 (62-63).
Windhausen, 236,471, Jan. 11, 1881 (62-153).
Fleming, 955,454, Apr. 19, 1910 (62-121).

[fol. 343] 1. Request for correction of the drawing should be made in a separate letter. Note Rule 8 and rule 72, paragraph 2.

2. Page 8, line 7 should be corrected.

3. Complete response has not been made to paragraphs 5 and 7, paper No. 4.

4. The specification should be completely reviewed and revised in order that the process and apparatus may be correctly and completely disclosed. The Office cannot undertake to point out all the discrepancies and inaccuracies in the specification. Although the operation of the invention is clear, as explained by applicant in the recent interview, the specification does not include a like clear explanation and the value of any patent which may eventuate from this application will depend greatly upon the accuracy and clarity of the specification.

5. No claim 2 appears in the application. The claims should be consecutively numbered.

6. Claims 1, 3 and 4 are rejected for lack of novelty and invention in view of the Elworthy patent. The steps of the process are all disclosed in the patent; the only difference between the claims and the patent is in that the claims specify a "closed pressure chamber" which relates to the apparatus and not to the process. The chamber *f* of the Elworthy device may be considered a closed pressure chamber which is an indefinite term at best.

[fol. 344] 7. Claims 5 and 6 are rejected for lack of novelty and invention in view of the Windhausen patent.

8. Claims 5 and 6 are further rejected as indefinite for the reason that no antecedent is recited therein for the phrase "source of supply". Also no positive structure is recited for the functional phrase "by withdrawing free gas".

9. Claim 6 is rejected for lack of novelty and invention in view of the Elworthy patent.

10. Claims 7 and 8 are rejected for lack of novelty and invention in view of the Hall patent.

11. Claims 7 and 8 are further rejected on the Elworthy patent for the reason that it would not involve invention to substitute the Derby separating means for the Elworthy separating means. The pipe *i* constitutes means for conducting the gas to any desired place.

12. Claim 9 is rejected for lack of novelty and invention in view of the Hall patent, the Naturels patent or the patent to Elworthy.

13. Claim 10 is rejected as indefinite. It recites only two steps "placing" and "permitting" and the latter is not a positive step. A process cannot rely on the single step of "placing".

14. Claim 11 is rejected as indefinite in the recitation of "a sufficient extent of insulation" which has no definite [fol. 345] interpretation. Also the phrase "means permitting" is obviously indefinite.

15. Claim 11 is further rejected for lack of novelty and invention in view of the Crepin patent.

16. Claim 12 is rejected on the Crepin patent and is further rejected as indefinite in the recitation of the capacity of the container, etc. The amount of refrigeration would depend on many variable quantities, such as the amount of material in the chamber, its temperature, the insulation, the outside temperature, etc.

17. Claim 13 is rejected being directly readable on the Crepin patent.

18. Claim 15 is rejected on the Moore patent for the reason that it would not involve invention to substitute

carbon dioxide snow for the ice in the bottom of the refrigerator in view of the Crepin patent.

19. Claims 16, 17 and 18 are rejected as vague and indefinite in the phrases "communicating between", "affording a passage", etc. As understood, these claims are rejected on the Elworthy patent.

20. Claim 17 is also rejected on the Windhausen patent which discloses the only feature of claim 17 differentiating it from claim 16.

21. Claim 14 may be allowed.

[fol. 346] 22. The claims should be greatly reduced in number. They are drawn mostly in vague and indefinite terms and do not clearly and concisely define the alleged inventions as required by the statutes.

23. Claims 1, 3, 4, 5, 6, 16, 17 and 18 are drawn to a process of and apparatus for making snow and are limited to the specific form shown on Fig. 1; claims 7, 8 and 9 are drawn to the method and apparatus for making snow, limited to the specific form shown on Fig. 12, claims 10 to 15 inclusive are drawn to refrigeration method and apparatus and claim 19 is drawn to a container of general application. Division is required among these four groups of claims only a single group of which is examinable in a single application. The patents illustrating the four groups are Elworthy, Elworthy (the first two groups being to separate species) Moore and Sharpe.

24. In view of the fact that this application was made special by the Commissioner, applicant is urgently requested to promptly formulate his claims in the concise and definite language required by the statutes, in order that an issue may be reached.

Paper No. 7

Amendment, March 4, 1924

Amend Fig. 1 of the drawing in the above entitled application as shown in red ink in the print accompanying the [fol. 347] amendment filed February 16, 1924, to illustrate

the siphon tube used in the particular conventional container of carbon dioxide illustrated in that view of the drawing.

A print of the sheet of the drawing containing this figure as originally filed is transmitted herewith.

Advise the attorney of any change for this drawing correction and remittance will be made promptly.

In response to action of February 28, 1924.

1. Request for correction of the drawing has been made in a separate letter.

2. Page 8, line 7 before "pressure" cancel "no" and substitute —atmospheric—

3. In further response to paragraph 5 of paper 4, amend page 7, line 21 by inserting after "trade"— The compressing apparatus just referred to may be either any ordinary tamping tool or a piston driven by power, such as will be disclosed in an improved form of my invention for which application for patent is about to be filed,—

In the interview had with the Examiner on February 15, 1924, there was exhibited a solid mass of carbon dioxide which had been compressed as described, and pieces of this carbon dioxide were broken off and dropped into a glass of water. They sank to the bottom, demonstrating the greater density of the product as compared with water, [fol. 348] and it was possible also to observe the bubbles of carbon dioxide as it evaporated from the frozen mass and came to the surface of the water and escaped over the edge of the glass in the form of a cold white vapor, visible to the eye, and which when a lighted match was placed in its path, extinguished the flame.

In response to paragraph 7 of paper 4, amend the specification, page 3, by inserting at the end of line 11— Such a manufacturing plant will include a suitable conventional heat exchanger to condense the surplus carbon dioxide gas which has not been refrigerated to snow to a liquid for delivery again through my pipe 4 to the converting chamber. The heat exchanger referred to is a machine of conventional type and is not illustrated or claimed as novel—

Page 7, after "valve 5" and before the insertion entered by the amendment of February 16, 1924, insert— The car-

bon dioxide gas thus returned to the source of supply 1, when that source of supply is a manufacturing plant, is condensed to a liquid by a suitable heat exchanger.—

As specifically pointed out in the specification as originally filed, page 3, lines 7-11, the element 1 may be "any suitable source of supply of liquid carbon dioxide" and may be "a manufacturing plant", such a plant being conventionally equipped with heat exchangers for reducing the carbon dioxide gas to a liquid state. At the interview had with the Examiner on February 15, 1924, a small apparatus, including a small conventional container of liquid carbon dioxide, such as illustrated in amended Fig. 1 of the draw- [fol. 349] ings was exhibited and operated, producing a small pellet of carbon dioxide snow in its light, porous form.

In addition to the demonstration given, it was demonstrated that the small device exhibited would condense carbon dioxide gas to a liquid and in turn freeze the liquid carbon dioxide to a solid in a single operation. In this case the refrigerating chamber was used as a heat exchanger. This also is true of the device illustrated in Fig. 1. Reference may be had to claim 4, beginning in line 6 regarding this point.

4. Page 8, line 25, for the sake of clearness add the following after "through the" and before "nozzle 24"—abruptly restricted passage of the—Page 8, line 26, after "Fig. 11" cancel the period and insert—whereby the liquid carbon dioxide flows under pressure until it passes the restricted passage of nozzle 24', said nozzle having an outwardly expanding mouth whereby to prevent clogging of the passage through the nozzle frozen carbon dioxide.—

Page 14, after line 5, enter the following new paragraph:

—The phrase "means permitting" or similar phrases referring specifically to the escape of carbon dioxide gas from evaporating carbon dioxide snow in a closed container shall be construed to apply to and define both a type of container having a small passage through its walls for the escape of the gaseous carbon dioxide or to the passage found or forced by the gas between the edges of a cover to the container and the wall of the opening in the con- [fol. 350] tainer which the cover rests upon and closes sufficiently for insulation from the outside air.—

The above amendments correct the specification by adding the description thought desirable to make details of the invention clear, and meet the requirements of the statutes, namely, that the invention shall be disclosed in such full, clear and exact manner as to enable those skilled in the art to which it relates to make and use it. Too great exactness and definiteness in defining the process and apparatus, especially in the claims, has been intentionally avoided in order not to limit the scope of protection afforded by the claims more than necessary. It is believed that the nature and extent of the invention warrants the use of broad terms, which the examiner possibly has referred to as "indefinite" without fully considering certain important differences between applicant's apparatus and process and the apparatuses and processes cited, as disclosed in prior patents. These differences will be pointed out below, in connection with the claims discussed.

5. Enter the following claim 2:

—2. The method of refrigeration which consists in placing in a chamber with the material to be refrigerated a suitably insulated solidified mass of an inert substance which at ordinary temperatures and pressures is a gas, and which on absorption of heat passes directly from the solid to the gaseous state, and permitting the gas as formed to permeate the chamber.—

[fol. 351] 6. With reference to claims 1, 3 and 4 it is clear that the chamber f of Elworthy is not a closed chamber, being open at the bottom and in open communication with but spaced from Elworthy's removable box m, and being thus open it cannot function as a "pressure chamber". Furthermore, the description of the nature of the product produced in this chamber f of Elworthy indicates that the chamber is not a closed chamber, if indeed Elworthy's device were operative. Its inoperative characteristics were pointed out in the amendment of February 18, 1924, in connection with the request, page 6 of that amendment, to reconsider claims 17 and 18. Claims 1, 3 and 4 can, however, be presented in a form that will define the invention in strictly process terms and it is requested that they be canceled and reentered as follows:

—1. A method of making carbon dioxide snow, consisting in conducting liquid carbon dioxide into a chamber while maintaining the pressure on the liquid, reducing the pressure in the chamber and withdrawing the free gas therefrom, and returning said free gas to the source of supply to be converted into liquid form for a repetition of the operation.—

—3. The method of making carbon dioxide snow, consisting in conducting liquid carbon dioxide into a chamber while maintaining the pressure on the liquid, reducing the pressure in the chamber and withdrawing the free gas from said chamber, whereby to convert a portion of the liquid carbon dioxide into carbon dioxide snow.—

[fol. 352] —4. In a method of making carbon dioxide snow, the process of conducting liquid carbon dioxide into a chamber while maintaining the pressure on the liquid, reducing the pressure in the chamber and withdrawing the free gas therefrom, and successively repeating the aforesaid steps and thereby applying the low temperature of each refrigeration to the succeeding refrigeration to cause the carbon dioxide to remain liquid at low pressure.—

Inasmuch as Elworthy discloses an apparatus which will not permit of carrying out the process as defined in claims 1, 3 and 4, his patent is not seen to be an anticipation of applicant's invention, and favorable reconsideration is urged.

Attention is called to the fact that the pipe 12 of Elworthy designated at h in chamber f does not indicate any means for reducing the pressure of the liquid carbon dioxide at this point but shows just an open pipe. The carbon dioxide would, therefore, expand and turn to a solid somewhere back in the pipe 12 probably about the point where pipe 12 leaves cylinder C'. Applicant's apparatuses on the other hand permit of reducing the pressure of the liquid carbon dioxide in the chamber where the refrigeration is desired and useful.

7. With reference to the patent to Windhausen, 236,471, it is noted that this patent relates to an apparatus for making water ice by a complicated mechanism not adapted to the making of carbon dioxide snow. Windhausen appar-

ently assumes that his vacuum pump will pump a complete [fol. 353] vacuum, which apparently would be necessary to cause the water to evaporate at 32 degrees Fahrenheit, and to do it at a practical rate it would be necessary to have more than a complete vacuum as the boiling point of water is 32 degrees at a complete vacuum or absolute zero pressure, which condition never has been obtained. The device of Windhausen would not work on gases with a boiling point below the freezing point of water and the gas above atmospheric pressure as in the invention disclosed by applicant. The refrigerating chambers A of Windhausen are not provided with means to operate under pressure, and certainly would not work with carbon dioxide under the high pressure necessary to hold liquid carbon dioxide. The device disclosed by Windhausen would not cool the water in tanks A below a point that would correspond to the completeness of the vacuum pumped by his vacuum pump. If other means of refrigeration were applied, it would not only have to refrigerate from that point to below the freezing point but the refrigerating chambers would in the Windhausen device have to have sufficient capacity to take care of the latent heat to be absorbed at the point of freezing, which is much the greater part of the energy required to make ice. The Windhausen apparatus is inoperative to produce ice. Reconsider claims 5 and 6.

8. Amend claims 5 and 6, lines 2, by inserting after "chamber" the phrase—a source of supply of liquid carbon dioxide under pressure— Claim 6, line 4, after "pressure" [fol. 354] and before "withdrawing" cancel "by" and substitute —and for—

9. As pointed out above, in connection with claims 1, 3 and 4, Elworthy has no closed pressure chamber; and lacking that essential element his apparatus is not seen to anticipate claim 6.

10. Amend claim 7, line 2, by inserting after "chamber" the following: —reducing the pressure on the liquid carbon dioxide as it enters said chamber to convert a portion of the liquid to snow, and the remaining portion to gas,—

The device of Hall (British) Patent 10,378 of 1910, discloses a container into which carbon dioxide is alleged to be

admitted through screens C-1 and C-2. Screens would not withstand a pressure of approximately 800 pounds per square inch on the liquid side of the screen against atmospheric pressure on the opposite side, and unless this can be done the snow would not be made at the point where the pressure reduction takes place, namely, the point back of the screen at which the flow of the liquid is sufficiently retarded to lower the pressure. This would result in clogging the device. Hall's device, therefore, is probably inoperative. If operative, his container is not of sufficient structure or strength to hold liquid carbon dioxide under sufficient pressure for it to remain a liquid, and therefore it could not under any circumstances operate as does applicant's apparatus shown in Fig. 1. Nor does Hall show the combination of apparatus to both produce carbon dioxide snow and to separate the snow and gas "by the op- [fol. 355] eration of both centrifugal force and gravity", which is required by the terms of applicant's claims 7 and 8. Reconsideration of said claims is requested.

11. As heretofore pointed out Elworthy has an open and not a closed chamber. (See his Fig. 1) and moreover were his device operative the separation of carbon dioxide gas and snow would be accomplished by gravity alone and not by a combination of centrifugal force and gravity, as defined and required by applicant's claims 7 and 8. The Derby device is a separating means merely; he does not make the dust which is the substance handled in his apparatus and the analogy of his apparatus to applicant's apparatus is, therefore, not such as to constitute an anticipation. It is clear that viewing Derby's device from the standpoint of a skilled mechanic looking forward and not looking backward, it would not convey the idea of how to make an apparatus for refrigerating carbon dioxide. The Derby device is clearly in a non-analogous art. Reconsideration is requested.

12. For reasons above set out in connection with claims 7 and 8, the Hall patent is not seen to anticipate claim 9. The same is true of the Elworthy patent which has neither a conduit terminating in a restricted passage nor a closed chamber. With reference to the Naturels (French) patent

514,037, it is not seen wherein this patent discloses any "conduit—terminating in a restricted passage for the ex- [fol. 356] pansion of the liquid carbon dioxide". Naturels discloses a device in which streams of the liquid are impinged upon each other for the purpose, it is alleged, of facilitating refrigeration. This is an entirely different operation and structure from that of the Slate apparatus and does not seem to be either necessary or advantageous. The separating means used in the Naturels device apparently is a cloth or muffler through which the gas escapes. Naturels requires a heating apparatus disclosed in 8-A, Fig. 1, which is not used or desired in the Slate apparatus but, on the other hand, the Slate apparatus is insulated from the atmosphere. In the Slate centrifugal acting device disclosed in Fig. 12 it will be noted that the snow and gas does not impinge on anything to retard its velocity, but, on the other hand, comes in contact with a circular wall in order to maintain its high speed to effect a separation of the snow and gas by both centrifugal force and gravity. Naturels is not shown to anticipate claim 9 and reconsideration is requested.

13. Claim 10 is believed to be sufficiently clear and definite to be readily understood; and the nature of the invention makes it necessary to define the process in but few steps. The last step of the process in this claim is really defined by the word "permeate" rather than by the word "permitting" and no amendment of the claim is seen to be necessary, as at present advised. Reconsideration is requested. The above comments will also apply to claim 2 which is drawn along the same lines as claim 10.

[fol. 357] 14. Claim 11, line 3, after "for" and before "extended refrigeration" insert —the—; same line, after "refrigeration" insert —desired—. The "extent of insulation" mentioned in this claim is determined by the "refrigeration desired"; and as the claim now stands amended it is thought to be as definite as it is desirable to have it in defining what is thought to be patentable subject matter. With reference to the phrase "means permitting"; the amendment which has already been directed to the body of the specification, page 14, after line 5, sets out

with exactness the construction that is to be placed on this phrase "means permitting", so that it is definite as applying to the two different means by which gas is permitted to escape from the containers in which the carbon dioxide snow is placed for refrigerating purposes.

15. Crepin (French) patent No. 333,181 of 1903 shows a container of carbon dioxide having a valve c in an otherwise open pipe e communicating with a reservoir f, which in turn communicates with a ribbed coil s the unrestricted open end of which discharges into the "casing a". The flow of liquid carbon dioxide from Crepin's container b will be retarded, if at all, at valve c where the carbon dioxide is solidified and not in chamber d. There is nothing to prevent the refrigerating chamber a from being overrefrigerated to some point above 112 degrees below zero Fahrenheit, and thereby using up the solidified carbon dioxide at such a rate that the contents of chamber a would be frozen for a short period, after which refrigeration would [fol. 358] cease. In applicant's apparatus several devices or means are disclosed whereby the refrigeration may be controlled to a practical degree of evenness. This is sought to be defined in claim 11. Furthermore, the Crepin patent apparently uses liquid carbon dioxide directly from a container, such a container having only a small percentage of the capacity of the solid carbon dioxide used in the Slate apparatus. On reconsideration, it is believed that claim 11 should be amended by cancelling "for" after "means" in line 1 of the claim and before "containing carbon dioxide snow", thus specifically including the carbon dioxide snow as an essential element of the claim, and it is requested that such amendment be entered and the claim reconsidered.

16. Claim 12, line 3, after "including" and before "insulating means" insert —substantial—; line 5, after "capacity" insert —and contents—; line 8, after "container" insert —under normal conditions—. As amended the claim is believed to be sufficiently definite to clearly describe what is sought to be patented. With reference to Crepin (French) patent the same comments apply as noted above with reference to claim 11 and reconsideration is requested, the fundamental idea and principle of applicant's invention

being distinct from Crepin, original, and of vastly greater usefulness than what Crepin discloses.

17. Claim 14, line 3, cancel "to" at the end of the line; line 4, at the beginning of the line cancel "hold the" and [fol. 359] substitute —holding—. As amended, the claim distinctly differentiates from Crepin (French), and the remarks noted above with respect to claims 11 and 12 should be taken into consideration in reviewing this claim, which it is thought should be allowed.

18. With reference to the patent to Moore, the attention of the examiner is particularly invited to the illustration of his element D^1 (Fig. 2) and to the description, page 1, lines 23 to 30, in which it is explicitly stated that this member is a sheet metal partition "joined by solder, in an air tight manner, to prevent the passage of air from one compartment to the other". Obviously, Moore's icebox cannot function in the manner made possible by applicant's construction nor can there be the automatic control of the temperatures of different portions of the refrigerating chamber set out in claim 15. Since the two devices do not operate in the same manner, anticipation by Moore is denied. Nor is Crepin believed to be pertinent to claim 15. Crepin shows an entirely different structure, with neither partitions nor doors. Also Crepin uses liquid carbon dioxide directly, which has only a small percentage of the capacity for refrigeration of solid carbon dioxide used in applicant's refrigeration apparatus, and specified in claim 15. Reconsideration of that claim is requested.

19. With reference to claim 16, the phrase "a conduit communicating between the first named conduit and the [fol. 360] compressor and affording a passage to the compressor" refers specifically to such a conduit as the pipe 15 of Fig. 1, the phrase "affording a passage to the compressor" being included to make entirely clear the direction of flow in reducing pressure within the insulated container 8 and withdrawing free carbon dioxide gas therefrom in carrying out the process of refrigeration described in the specification. It is thought that on reconsideration the examiner will agree with the view of the attorney that the language is sufficiently clear and definite. With reference to Elworthy, his device has a conduit from the source

of supply running through what appears to be and is described by him as a liquid engine, and not a compressor; another conduit leading from the engine to the ice-making device, so called, of Elworthy; and a conduit leading from the ice making device directly to the first stage of his recompressor. In the Slate apparatus the conduit for supplying the ice-making apparatus with liquid carbon dioxide is direct from the source of supply (element 1) to the ice making device (insulated container 8) through valve 5, and the compressor (17) is intermittently thrown into the line and included as a part of the cycle of operation by closing the valve 5, which is referred to in claim 16 as "a vavle in the first named conduit positioned at a point in the conduit between the juncture of the second and third conduits with the first named conduit." This is not accomplished by Elworthy either by the provision of such a combination of mechanical elements or by the process performed by the Slate apparatus. Allowance of claim 16 is requested.

[fol. 361] 20. Amend claim 17 by cancelling the period at the end of the claim and adding:—adapted to tightly seal the container and withstand the high pressure from within the container necessary to retain liquid carbon dioxide in its liquid state—. As amended, claim 17 differentiates in a vital respect from the device disclosed in the Windhausen patent. In the case of the Windhausen machine, a partial vacuum is created in his chambers A, whereas in applicant's container 8 high pressure is exerted from within the container by liquid carbon dioxide. The cover d of Windhausen is not adapted to withstand high pressure from within the chamber, being merely the type of sealing device used on fruit jars where the sealing action is due to a partial vacuum created under the cover within the jar. Amend claims 17 and 18, line 1 by cancelling "17" and substituting 16 to agree with the renumbering of the claims made by the amendment of February 18, 1924. The comments above will also apply to the subject matter of claim 18, as regards the pertinence of Elworthy and Windhausen.

21. It is noted that claim 14 is allowed. It is understood that claim 19 also is allowed, no rejection being entered against it.

22. As at present advised, and in view of the explanations and amendments entered it is believed that on reconsideration the Examiner will withdraw the suggestion for a reduction to any great extent in the number of claims, and [fol. 362] the criticism as to alleged indefiniteness in terms, such indefiniteness being necessary in certain instances to give the claims the scope desired. It is believed they will be clear when read in the light of the description and drawings of the specification.

23. The requirement for division into four groups of claims each covering a separately patentable invention or species is noted and will be complied with, at an early date. It is especially requested that in considering the claims thus transferred to such divisional applications from the present parent application that the Examiner consider the arguments and explanations submitted in this amendment and also in the amendment of February 18, 1924, bearing on the claims which are transferred from this application to the new divisional applications to be filed. For the purposes of complying with the division requirement, cancel claims 1, 3 to 9 inclusive, and 16 to 19 inclusive, and renumber claims 2, 10, 11, 12, 13, 14 and 15, to 1, 2, 3, 4, 5, 6 and 7 respectively. The direction for cancellation noted above includes claims 1, 3 and 4 newly entered on pages 4 and 5 of this amendment. These claims will reappear in a divisional application soon to be filed. They were presented on pages 4 and 5 of this amendment in order to make a complete answer to paragraph 6 of the examiner's action. In further compliance with the division requirement amend as follows:

Page 2, cancel the short description of Figs. 1 to 5 inclusive; cancel the brief description of Figs. 12 and 13, all of [fol. 363] which relate to divisional subject matter; and in the brief descriptions of the Figures, beginning in line 8, page 2, and ending with line 1, page 3, change the numbering of the figures in these brief descriptions, after the word "Fig." from 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23 to 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 and make a similar correction in the body of said descriptions where the word "Fig." occurs, viz: in line 12 of page 2, at the end of the line, "8" should be changed to —3—;

line 13, "7" should be changed to —2— and page 3, line 1 also at the end of the line "22" should be changed to —15—.

Page 3 cancel the matter beginning in line 4 with "Referring to the accompanying drawings and particularly to Figs. 1 to 5" and ending with "valve 5" in line 23 as relating to divisional subject matter limited to the specific form shown on Fig. 1.

Page 4 cancel the first paragraph beginning with "Referring to Fig. 12" in line 1 and ending with "nozzle 24" in line 7 as relating to divisional subject matter limited to the specific form shown on Fig. 12. Page 10 cancel lines 10 to 25 inclusive, for the same reason.

Page 7, cancel lines 1 to 18; and on page 8 cancel lines 7 to 18 inclusive as relating to divisional subject-matter limited to the specific form shown on Fig. 1; same page line 19 at the beginning of the line cancel "Another" and substitute —A—.

To make the reference to figures in the body of the speci- [fol. 364] fication agree with the changed numbering of the figures, in the brief descriptions, amend as follows:

Page 3, line 23, after "Figs." change "6 to 11" to —1 to 6—. Line 28, after "Fig." cancel "7" and substitute —2—. Last line after "Figs." cancel "6 and 7" and substitute —1 and 2—.

Page 4, line 8, after "Figs." cancel "6 and 7" and substitute —1 and 2—; line 11, after "Figs." cancel "6 and 12" and substitute —1— and singularize "Figs." Line 26, after "Fig." concel "11" and substitute —6—; line 29 after "Figs." cancel "14 and 15" and substitute —7 and 8—; line 30, after "Figs." cancel "6 and 7" and substitute —1 and 2—.

Page 5, line 4, after "Figs." cancel "6 and 7" and substitute —1 and 2—; same line, after "Fig." cancel "16" and substitute —9—; line 5, after "Fig." cancel "17" and substitute —10—; line 7, after "Fig." cancel "18" and substitute —11—; line 18, after "referring to" cancel "Fig. 20 to 23" and substitute —Figs. 13 to 16—; line 20, after "Fig." cancel "21" and substitute —14—; line 27, after "Fig." cancel "22" and substitute —15—.

Page 6, line 21, after "Fig." cancel "22" and substitute

—15—; line 23, after "Figs." cancel "18 and 19" and substitute —11 and 12—.

Page 8, line 23, after "Fig." cancel "6" and substitute —1—; lines 23-24, after "to" cancel "pipe 4 on the supply side of Fig. 1" and substitute —a suitable source of supply of liquid carbon dioxide under pressure—; line 26, after "Fig." cancel "11" and substitute —6—.

Page 9, line 5, after "as illustrated in" cancel "Fig. 6 [fol. 365] and 7" and substitute —Figs 1 and 2—; line 16, after "Fig." cancel "6" and substitute —1—.

Page 10, line 25, after "Fig." cancel "14" and substitute —7—; line 29, after "Figs." cancel "6 and 7" and substitute —1 and 2—; line 31, after "Figs." cancel "6 and 7" and substitute —1 and 2—.

Page 11, line 1, at the beginning of the line, cancel "6 and 7" and substitute —1 and 2—; line 2 at the end of the line cancel "6" and substitute —1—; line 3 at the beginning of the line, cancel "and 7" and substitute —and 2—; line 7 after "Figs." cancel "18 and 19" and substitute —11 and 12—; line 23, after "Figs." cancel "22-23" and substitute —15 and 16—; line 26 correct the spelling of utilize.

Cancel Figs. 1 to 5 and Figs. 12 and 13 of the drawings which figures relate to divisional subject matter and will be presented in divisional patent applications responsive to the divisional requirement of the Examiner.

24. All possible expedition had been used consistent with careful preparation of the amendment in view of the fact that this application was made special by the Commissioner. As foreign references were cited by the Examiner some time was required for securing the necessary translations and for making copies of the drawings of these foreign references. In view of the full response made it is hoped that an early favorable action can be given.

[fol. 366] Paper No. 9

Amendment, March 22, 1924

Supplementing the amendment of March 18, 1924, it is requested that the four lines directed to be inserted in line

21 of page 7, as set forth in paragraph numbered 3, be cancelled.

Allowance March 24, 1924.

Paper No. 10

Amendment under Rule 78, August 5, 1924

Enter the following formal amendments:

Page 31, line 26, insert a period after "refrigerant" and cancel the phrase "and its light weight". Line 29, after "as" cancel "it is light" and insert —a given weight of compressed carbon dioxide snow will produce much greater refrigeration than the same weight of water ice, and it is—. Line 30, insert a period after "handled" and cancel "but", and capitalize the succeeding "A". Cancel "not only".

Paper No. 14

Amendment under Rule 78, Sept. 24, 1924

It is respectfully requested that the following amendment be entered under Rule 78 without withdrawal of the case from the issue. It is believed that all of the proposed amendments are of the type urged by the Primary Examiner in his letter of February 28, 1924, paragraph 4.

Page 3, after line 24, and page 5, after line 6, and page 5, after line 17, insert:

[fol. 367] As explained in connection with Fig. 15, these chambers 20 and 22 may be formed of or insulated by balsa wood or similar material.

Page 5, line 1, after "26" insert: Absorbs in latent form, the heat conducted to it through the walls of the container, it

Page 5, line 15, after "products" insert: by absorption of latent heat and

Page 7, line 19, cancel "as it thus comes from the device", and insert: deposited by the method shown in Figs. 1 to 6.

Page 7, line 20, cancel "it" and insert: it may be

Page 7, line 24, cancel beginning with the word "making", through to the end of the sentence in line 28.

Page 8, line 19 change "6 to 13" to read: 1 to 6.
Page 9, last line, after "required", insert:

and this depends upon the nature of the perishable products to be refrigerated and upon the amount of heat which the chamber will absorb from the outside.

Page 10, after line 9, insert the following:

It is well known that in snow making the amount of carbon dioxide released as gas is substantially greater than that retained as snow. Hence in charging chamber 22 the refrigerant effect produced by discharge of said gas into the [fol. 368] refrigerator atmosphere will be greater than that producible by melting all of said snow, and it is obvious that such method will be particularly useful where small charges are admitted at short intervals; also where the cargoes are of frozen products which would not be harmed by the intense cold that would be produced by a long charging operation, such as would be necessary to produce a store of snow sufficient for a long trip.

This intense initial refrigeration is avoided by the method shown in Fig. 7, in which I employ already manufactured

Page 10, cancel line 10 from the bottom.
Page 10, line 3 from the bottom, before "Any", insert:

Such escaping gas functions in substantially the same manner as the gas escaping from the ice in the above described apparatus in Figs. 1 to 6, but as the intense prerefrigeration is lacking, a larger container and more snow or ice may be required for maintaining refrigeration under conditions which are otherwise similar.

Page 10, last line, after "chamber 8", insert the following:

(now shown in my divisional application Ser. No. 702,677).

Page 13, line 18, after "it", insert: as a liquid.
[fol. 369] At the end of the specification add the following:

While I have shown and described several specifically different methods and devices involving my present inven-

tion, it is to be noted that the most specific claims hereof are limited to the refrigerator shown in Figs. 13 to 16 inclusive; while progressively broader claims cover the device of Figs. 11 and 12, that of Figs. 7 to 10 and that of Figs. 1 to 6, and specific claims for the specific devices and methods not specifically claimed herein are reserved for other applications filed or about to be filed by me.

After claim 2 insert the following:

3. The method of refrigeration which consists in inclosing within a chamber with the material to be refrigerated, a quantity of suitably insulated carbon dioxide in solidified mass form, which on absorption of heat from the atmosphere within the chamber, passes directly from the solid to the gaseous state; and permitting all the gas thus formed to escape into and permeate the chamber.

4. The method of refrigeration which consists in enclosing within a chamber, with the material to be refrigerated, a quantity of suitably insulated carbon dioxide which has been previously frozen and is in solidified mass form, and which on absorption of heat through the insulation passes directly from a solid to a gas much heavier than [fol. 370] air; and permitting all the gas to escape into said enclosing chamber, as formed, and to flow downward in said enclosing chamber, displacing the air upward.

After claim 3 insert the following:

6. In a refrigerating system, including a suitable chamber enclosing means for containing frozen carbon dioxide, said containing means including an amount of insulation predetermined in accordance with the amount of refrigeration required so as to conserve the frozen carbon dioxide for the extended refrigeration desired and prevent overrefrigeration of the product to be refrigerated, and means permitting escape of the gas from the melting carbon dioxide into said chamber for the use both as a refrigerant and as a preservative by utilizing the escaping gas to prevent deterioration of perishable products.

7. In a refrigerating system the combination of a chamber to be refrigerated, a container of frozen carbon dioxide within the chamber, said container being formed of

or including substantial insulating means, the capacity and insulation of the container being suitably proportioned to the total capacity and contents of the chamber to be refrigerated so as to effect the required amount of refrigeration by latent heat absorption and by the escaping carbon dioxide gas attendant upon and resulting from evaporation of the frozen carbon dioxide within the aforesaid container, under normal conditions.

8. A refrigerating system adapted to and using previously frozen carbon dioxide as the refrigerant, said sys- [fol. 371] tem including a chamber to be refrigerated, and, wholly enclosed within and venting into said chamber, a substantially closed, insulated container holding the frozen carbon dioxide and adapted to produce a desired refrigeration by the absorption of latent heat and by the cold carbon dioxide gas resulting from the evaporation or melting of the frozen carbon dioxide, the specific gravity of the gas being utilized to exclude air and moisture from the products to be refrigerated.

Renumber claims 3 as 5 and 4 to 7 as 9 to 12 respectively.

Remarks

The explanation with respect to the material of the containers 20 and 22 of the apparatus shown in Figs. 1 and 2, that shown in Figs. 7 to 10, and that shown in Figs. 11 and 12 are obviously desirable, since such description is heretofore hidden away in a parenthetical clause describing the thermos bottle container of Fig. 15, see page 6, lines 23 to 26.

Cancellation of the first half of page 7 makes the word "thus", line 19, inappropriate and the amendment makes suitable correction.

The cancellation at the end of this same sentence and at the end of the following sentence are to eliminate statements not particularly pertinent to the present invention.

The correction, page 8, line 19, is shown to be necessary by the attorney's copy of the amended specification.

[fol. 372] The insertion at the bottom of page 9 is an obvious explanation of what is meant by the words "amount of refrigeration required".

Insertion page 10, line 9, is an obviously true statement

of the facts of the case and is a laudable caution to the user as to what may be expected from the use of the apparatus shown in Figs. 1 to 6; also the distinction as to the practical difference attendant upon the use of the method described in connection with Fig. 7.

The correction page 10, last line, is necessary since previous amendments have eliminated from the case the chamber 8, pipe 15 and compressor 17 here referred to.

The paragraph added at the end of the specification distinguishing between the subject matter claimed therein and that claimed in divisional applications is obviously desirable and is necessary to preserve the applicant's rights.

On careful study of the claims, it is evident that, in addition to the good claims already allowed, some more precise and specific claims directed to the same subject matter, are desirable. Thus, proposed claim 3 is similar to, but more specific than, allowed claim 1, and the same is true as to proposed claim 4 as compared with allowed claim 2.

Claims 6, 7 and 8 are, respectively, more specific than allowed claims 3, 4 and 5.

As all of these claims are more specific than the allowed claims, it is submitted that no further examination of the art is necessary, and this being obvious from cursory examination, the Examiner is respectfully requested to so [fol. 373] certify and to recommend the amendment for admission without withdrawal from the issue.

Paper No. 15

Supplemental Oath (as to Amendment), Sept. 24, 1924; Office Action, Sept. 25, 1924

1. This amendment, under Rule 78, has not been entered at this time, for the reason that the specification is in type and the entry of the amendment should receive the final approval of the Commissioner before entry. However, the Issue and Gazette Division has not received the proof and informs the Examiner that the amendment may be entered if approved.

2. The proposed amendments are deemed each desirable for reasons clearly explained by the applicant in his "remarks". At least three of the changes are necessary to

correct defects which would be obvious on the face of the patent.

3. The proposed claims are more specific than any of the allowed claims and are deemed to more clearly define and protect the invention. It is therefore recommended that the amendment be entered.

Approved.

C. H. Shaffer, Examiner. Wm. A. Kirman, Acting Commissioner of Patents.

Sep. 25, 1924.

[fol. 374] DEFENDANT'S EXHIBIT B

Abstract of File Wrapper and Contents of Slate Patent No. 1,595,426, Granted August 10, 1926, for Improvement in Refrigerating Apparatus

Application Serial No. 740,164. Filed September 27, 1924. For Refrigerating Apparatus and Methods

The original specification and claims were as follows:

My present invention relates more particularly to refrigerating perishable products by means of frozen carbon dioxide enclosed in a suitable insulated container which has the products to be refrigerated above, below and around it so that its insulated walls operate to absorb heat from the perishable products and from the surrounding atmosphere within the refrigerator, and to apply said heat to the frozen carbon dioxide whereby it is absorbed as latent heat, producing a corresponding amount of intensely cold carbon dioxide gas without any intermediate liquid state, said gas being liberated in operative relation to refrigerate such products, dry them, and protect them from air. Various forms of apparatus working on this principle are set forth in my application, Serial No. 685,482, filed January 10, 1924, of which this application is a division.

The subject matter of this present application is a heavily insulated package or shipping case filled with perishable products, preferably such as is desired to keep very cold and to preserve from the atmosphere, as for instance,

yeast or ice cream or hard frozen products which are placed [fol. 375] in said refrigerator case, under, over and around the insulated container of frozen carbon dioxide.

The above and other features of my invention may be more fully understood from the following description in connection with the accompanying drawings, in which

Fig. 1 is a vertical section through a shipping case containing food products and a carbon dioxide snow chamber or refrigerant contained in the center thereof; and

Fig. 2 is a vertical section through the chamber 22.

As shown in these drawings, I provide a simple means using the insulated container 22 for the frozen carbon dioxide within a small shipping box or refrigerator 20 for the shipment of small quantities of perishable products 57, which are thus easily and efficiently refrigerated. By making snow chamber 22 of the proper size to displace a given number of packages of the perishable products to be shipped and by filling chamber 22 with frozen carbon dioxide and placing it in the midst of the said products shipped, it will slowly and gradually refrigerate those products by the escaping gas which forces its way under the lid of chamber 22 and continuously keeps the air and moisture displaced.

The container 22 for the frozen carbon dioxide, as also the shipping container 20, may be of balsa wood, but may have the vacuum-wall type of insulation if found desirable. As shown, the covers of both the shipping box and the refrigerant container are close-fitting, and the walls are of exceptional thickness.

[fol. 376] As stated in my prior application, carbon dioxide snow as deposited, is light and porous, but I prefer to use it in ice form, made either by highly compressing the snow or by freezing the carbon dioxide directly. As the carbon dioxide ice is nearly twice as dense as water ice and affords nearly twice as much refrigerant value per pound, it is particularly desirable for shipping purposes where express or freight charges are important.

In this form of my invention where the container or the carbon dioxide is midway of the products to be preserved, it is desirable to proportion the amount of insulation so that over-refrigeration or freezing of the products will be prevented, but this is not necessary where the products

are such as not to be harmed by intense cold, and are such as to benefit by exclusion of air and moisture. I claim:

1. The method of refrigeration which consists in packing in an outer insulated container with the material to be refrigerated, a relatively small, suitably insulated inner container enclosing a quantity of frozen carbon dioxide which on absorption of heat through the insulation of said container, passes directly from the solid to the gaseous state; and permitting the carbon dioxide gas, as formed; to escape among said materials at a point below the uppermost and above the lowermost thereof.

2. The method of refrigerating shipping packages which [fol. 377] consists in placing in a suitably insulated package with the material to be shipped, a quantity of frozen carbon dioxide suitably insulated from but surrounded by said materials, and which on absorption of heat through said insulator, passes directly from the solid to the gaseous state; and permitting the gas, as formed, to escape among said surrounding materials.

3. The combination of a shipping case to be refrigerated, a container of frozen carbon dioxide packed in the case with perishable products, said container being formed of or including substantial insulating means in contact with parcels of said materials, the capacity of the container being suitably proportioned to the size and contents of the package to be refrigerated to effect the required refrigeration by the refrigerating, preserving and moisture absorbing action of escaping carbon dioxide gas produced by the evaporation of the frozen carbon dioxide within the aforesaid container, under normal conditions.

4. An insulated shipping case, similar parcels of perishable products packed solidly in said case, surrounding and supporting an insulated container of frozen carbon dioxide, having dimensions corresponding to and fitting among the said parcels.

5. An outer insulated chamber enclosing a relatively small, suitably insulated inner container adapted to contain a suitable quantity of frozen carbon dioxide, said container being located approximately midway between

the top and bottom of said outer chamber so as to afford [fol. 378] storage space for perishable products above and below it, said container there absorbing heat and permitting escape of the resultant cold carbon dioxide gas among said parcels, as formed.

6. An outer enclosing chamber formed of or provided with suitable insulating material and containing perishable products; and an inner container for frozen carbon dioxide of much smaller size, located within said enclosing chamber and in direct contact with, and absorbing heat from, and discharging resultant cold carbon dioxide among parcels of said perishable products, the capacity of said container and its insulation being proportioned to the amount of refrigeration required by said products.

Paper No. 2

Rejection, January 29, 1925

References:
Hargrave, 625,760, May 30, 1899 (62-6).
French, Crepin, 333,181, June 17, 1903 (62-92), 1 sht.

1. The patent which resulted from the application should be mentioned on page 2, line 14.

2. Claim 1 is rejected as indefinite in the phrases "relatively small" and "suitably insulated", as the part to which the small container is compared is not mentioned and "suitably" is obviously any value whatever from no insulation at all to complete insulation.

3. Claim 1 is further rejected as indefinite in that it is apparently a mixture of specific apparatus and process steps.

[fol. 379] 4. Claim 1 is further rejected on the Crepin patent which shows the two steps of packing and permitting gas to escape.

5. Claim 2 is rejected on the Crepin patent and as indefinite for reasons given concerning claim 1.

6. Claim 3 is rejected on the patent to Crepin for the reason that it would not involve invention to insulate the

container F of the Crepin device in view of the patent to Hargrave. Claim 5 is rejected for the same reason.

7. Claim 3 is further rejected as indefinite and functional in that "the required refrigeration" is entirely indefinite.

8. Claim 5 is rejected, being not readable on the disclosures. There is no means of supporting the cooling element so as to afford a space as claimed. When the cooling element is supported, the space is filled with articles being preserved and no storage space is afforded. Claim 5 is also indefinite in the term "suitably".

9. Claim 6 is rejected as indefinite and functional. The phrase commencing "located within" has no basis of positive structure. As understood, claim 6 is rejected on the Crepin patent.

10. Claim 4 appears to be directed to allowable subject matter as now advised.

[fol. 380] Paper No. 3

Amendment, January 29, 1926

Please amend the above entitled case as follows:

Page 2, at the beginning of line 14, insert: patent No. 1,511,303, granted October 14, 1924, on my

Page 2, line 19, after "atmosphere" insert: and particularly such as are not damaged by temperatures far below freezing.

Page 3, last line, cancel "is" and insert: may be

Page 4, line 1, after "or" insert: —over—

Page 4, at the bottom add:

From the above, it will be evident that my present invention differs from all the other forms described in my said prior application and patent in the particular that the carbon dioxide snow or ice refrigerant is in or among packages or masses of the perishable products whereby certain portions of the perishable products are in close proximity to this intense refrigerant, as for instance, portions of packages in contact with the refrigerant container, while other portions are relatively remote, as for instance, those near or in contact with the outer walls of the shipping or storage

case. Obviously, the products close to, and particularly those in contact with, the carbon dioxide container, are certain to be reduced to temperatures far below parts of the mass that are more remote. This is very different [fol. 381] from the situation in all of the other forms shown in my said patent, wherein all of the products are refrigerated by convection currents more than by actual conduction of the heat through portions of the product that are refrigerated.

So far as concerns the specific method, my present invention is therefore clearly distinguishable from arrangements of the type shown in Fig. 15 in said patent, wherein there is a refrigerator particularly adapted for products requiring widely different temperatures, but all refrigerated from a single source of convection currents which take effect first on the products that are not damaged by over-freezing and subsequently on other products that are not to be frozen. As contrasted with this, the specific method hereof contemplates a box or case in which all of the products to be refrigerated are of the same kind, all of them, even the remotest, are to be kept near or below freezing; and none of them are damaged by severe over-freezing that will occur in those portions most directly exposed to the refrigerant.

Claim 1, line 1, cancel "refrigeration" and insert: preserving like masses or parcels of a perishable product of the type not damaged by severe over-freezing.

Same claim, lines 2 and 3, cancel "with the material to be refrigerated, a relatively small, suitably" and insert: [fol. 382] among masses or parcels of such perishable product and in close proximity thereto, an

Same claim, cancel the last two lines and insert: escape among said masses or parcels of said perishable product.

Claim 2, line 2, cancel "suitably" and insert: heavily

Claim 2, line 3, cancel "with the material to be shipped" and insert: and in close proximity to like parcels or masses of material not damaged by over-freezing during shipment

Claim 2, line 4, cancel "suitably".

Claim 2, line 5, cancel "materials" and insert: parcels or masses so that portions of the material are more directly and intensely refrigerated than other portions for the purpose and with the result of sufficiently refrigerating more remote portions.

Claim 3, line 6, cancel "suitably"; lines 7 and 8, cancel "to effect the required refrigeration" and insert: so as to maintain the products in frozen condition for the desired length of time.

Claim 5, line 2, cancel "suitably"; line 3, cancel "suitable"; lines 5 and 6, cancel "so as to afford storage space for" and insert: and supported by parcels of the

Claim 6, lines 1 and 2, cancel "enclosing chamber formed of or provided with suitable insulating material and" and insert: thick walled balsa wood case or box; same claim, line 2, after "containing", insert: like parcels of; same claim, line 4, cancel "enclosing chamber" and insert: outer case.

[fol. 383] Remarks

The above amendment is for the purpose of complying with the Examiner's requirements and also for the specific purpose of pointing out how different are the present apparatus and method based on Figures 11 and 12 of applicant's prior patent, as contrasted with any and all other apparatus and methods set forth in said patents. The problem is different; the relations of the perishable product and the snow are different; and the difference is best evidenced by contrast of this apparatus with that shown in Fig. 15 of the patent, as has now been done in an amendatory addition to the specification.

Referring specifically to the Examiner's requirements as paragraphed in the Office letter, these may be answered as follows:

1. The patent is now referred to by number and date.

2. The indefinite expressions have been eliminated and definite ones substituted where necessary.

3. Reconsideration of this objection is requested. It is clear that the idea of a shipping case with the frozen carbon dioxide in and among packages of the perishable products involves a method as now defined, and that said method is of great utility where the perishable product is one that must be frozen and is not damaged by over-freezing. The fact that the method results from use of certain apparatus

[fol. 384] in a certain way does not invalidate the method as such.

4. The Crippen patent does not show any steps of packing either of the frozen carbon dioxide or of the materials to be refrigerated. It shows an ordinary refrigerator with ordinary shelves, in which the refrigeration is entirely by convection and there is no possibility of the snow container being close to or in contact with the materials to be refrigerated, nor is the refrigerant gas discharged directly against or among said material. The materials are obviously only food products and, in so far as the operation is analogous to anything applicant does, it is analogous to his refrigerator shown in Fig. 15 of the parent case.

5. The rejection of Claim 2 on Crepin is answered in the foregoing paragraph 4.

6. The rejection of Claim 3 is similarly answered. A shipping case packed with perishable products is entirely remote from anything suggested by Crepin. Hargrave shows only an insulated container for liquid air and even if this container had carbon dioxide snow in it, it could not be packed in with other packages without rendering it inoperative for its intended purpose. Adding Hargrave insulation to Crepin would not bring the latter any nearer to the above defined novel features of applicant's invention.

7. Claim 3 has been amended to define what is "the required refrigeration".

[fol. 385] 8. Claim 5 has been amended to define how the cooling element is supported and also to eliminate "suitably".

9. Claim 6 has been made definitely by amendment. It is not understood what fault is found with "located within". In the form shown, there is no positive structure for supporting the snow, but applicant is clearly entitled to cover broadly the novel feature of having the inner container located anywhere within the outer case so long as it is in direct contact with the parcels of perishable products. The rejection on Crepin has been answered in the preceding paragraphs 4 and 6.

10. Claim 4 is allowed.

11. Reconsideration and allowance of the case as now amended is respectfully requested.

Paper No. 4

Rejection, March 4, 1926

In response to the amendment filed Jan. 29, 1926.

1. Claims 1 and 2 as amended are rejected on the ground that they do not define a true process. All that applicant has shown is a package consisting of an insulating casting, articles to be kept cool and a solid refrigerant located in the center of the package. This method of cooling is obviously old. The mere substitution of one solid refrigerant [fol. 386] for another does not make a new process of cooling, but it may make a new package.

2. Claim 3 is again rejected on the Crepin patent taken with the Hargrave patent for the reason given under paragraph 6 of paper #2.

3. Claim 3 is also rejected as indefinite for the reason that there is no antecedent for "panels of said materials".

4. Claim 5 is rejected as indefinite in that there is no antecedent for "parcels of perishable products". This claim should be amended so as to positively include the parcels as in claim 4. For example, after "chamber" in line 5, insert "parcels of perishable products within said outer chamber supporting said inner container from above and below, etc." If so amended, claim 5 will be allowed.

5. Claims 4 and 6 are allowable as at present advised.

Paper No. 5

Amendment, June 24, 1926

Please amend the above entitled case as follows:

In the preamble, page 1, line 6, cancel "and methods".

Page 2, line 21, change "placed" to packed; same line, cancel "under, over and around" and insert: in close heated exchange relation with; line 22, after "dioxide"

[fol. 387] add: and the fresh intensely cold gas escaping from said container.

Page 3, cancel the last line and page 4 cancel the first four lines, and insert the following:

preserved, it is evident that the insulation cannot prevent freezing of some or all of said product because regardless, of insulation, the fresh gas escaping from the inner container impinges directly on adjacent products before it has any opportunity to diffuse or to become warmed the 140° or more F. which would be required to reach the relatively high freezing point of water.

Claim 3, line 5, cancel "parcels of said materials" and insert: said perishable products

Cancel claims 1, 2 and 5 and renumber Claims 3, 4 and 6 as 8, 9 and 10, respectively.

Insert the following claims:

1. A package for transporting and preserving masses or parcels of a perishable product of the type not damaged by severe over-freezing which consists of an outer insulated container, in which are packed masses or parcels of such perishable product in close proximity to an insulated inner container enclosing a quantity of frozen carbon dioxide which on absorption of heat through the insulation of said container, passes directly from the solid to the gaseous state; said inner container permitting the carbon dioxide gas, as formed, to escape in freezing proximity to said masses or parcels of said perishable product.

2. A heavily insulated package enclosing in close proximity to a parcel or mass of material not damaged by over-
[fol. 388] freezing during shipment, a quantity of frozen carbon dioxide insulated from but in freezing relation to said parcel or mass so that portions of the material are more directly and intensely refrigerated than other portions for the purpose and with the result of sufficiently refrigerating more remote portions, whereby on absorption of heat through said insulation, said carbon dioxide passes directly from the solid to the gaseous state; and said gas, as formed, escapes in freezing and insulating relation to said materials.

3. A transportation package consisting of a protective casing of insulating material enclosing a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product in freezing proximity to said carbon dioxide and the gas evaporated therefrom and arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

4. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product insulated from but in freezing proximity to said frozen carbon dioxide and the gas evaporated therefrom.

5. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of frozen carbon dioxide in an insulating container and [fol. 389] a quantity of freezable product in freezing proximity to said frozen carbon dioxide and the gas evaporated therefrom.

6. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of frozen carbon dioxide in an insulating container and a quantity of freezable product in freezing proximity to said frozen carbon dioxide and the gas evaporated therefrom, arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

7. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of freezable product in freezing proximity to a quantity of frozen carbon dioxide sufficient to afford the desired amount of refrigeration.

Remarks

1. In defcrence to the Examiner's suggestion that the invention of Claims 1 and 2 may be covered as a new package, Claims 1 and 2 have been rewritten. The further suggestion that "this method of cooling is obviously old" seems entirely unwarranted, however. Applicant has created a new art along entirely new lines, and, though most exhaustive researches have been made in patents and litera-

ture of this and all foreign countries, no anticipation has been found for applicant's present method, much less the Crepin and Hargrave patents discussed below. The use of carbon dioxide for this purpose possesses unique advan- [fol. 390] tages in comparison with the use of water ice; the ice is dry and non-melting, thus protecting waterproofing and avoiding the use of metal containers, the gas is non-oxidizing, and therefore has no deleterious effect on metallic food containers; and the gas is also a food preservative besides being a refrigerating agent.

2. Neither Claim 3 nor any of the other claims define features in any way anticipated by Crepin. Crepin has an ordinary refrigerator in which the products to be refrigerated are purposely kept for remote from the heat absorbing surfaces and from the refrigerating medium. The source is liquid carbon dioxide stored in the usual high pressure container or bottle located inside of the refrigerator. Whenever the operator thinks the refrigerator is too cold, he opens the valve "c" by hand, presumably, although a thermostatic valve would certainly not improve the reference or make it more relevant. To one familiar with such apparatus, it is evident that Crepin feared over-refrigeration and freezing such as would be likely to result if the inevitable carbon dioxide snow were projected directly into the refrigerator when the valve c is open. Therefore, he arranges an elaborate trap in which any such snow will be caught and melted and then adds a large capacity heat exchange tube or "radiator" to further make sure that the gas will be warm before it escapes. As an additional precaution, to prevent too rapid escape of the gas, he arranges a capillary tube m to act as a throttle between the supplemental reservoir tank d and his radiator tube s. Such a [fol. 391] capillary tube is necessarily of extremely small flow capacity and even this is likely to be cut down by clogging with fine particles of the snow.

In view of the relatively enormous volume of atmosphere within the refrigerator, cooled only by a capillary tube supply of gas applied through a very effective large volume radiator coil, said atmosphere will be kept, and is designed to be kept, substantially above freezing point.

Supposing, however, that Crepin's apparatus were designed to maintain a temperature of 50° below zero, it

would still have no bearing whatever on applicant's present invention, wherein an insulating gase is packed with perishable products and an insulated mass of frozen carbon dioxide so that there is no opportunity whatever for the gas to warm or diffuse before it is applied to the adjacent perishable products.

The Hargrave patent has no bearing on Crepin, nor neither alone nor taken with Crepin, does it have any bearing on applicant's invention. Hargrave shows a bottle of liquid air adapted to be exposed directly to the atmosphere by a thermostat which opens and closes a wall of an insulating jacket in which the bottle is embedded. If this jacket were solid and could not be opened by the thermostat, it would still have no bearing on applicant's invention. If it contains frozen carbon dioxide instead of liquid air, it would still have no bearing on applicant's invention. If it were put in Crepin's refrigerator either filled with liquid air or with frozen carbon dioxide, the combination would have no bearing on applicant's invention.

In short, it is impossible for the attorney to see why [fol. 392] either of these references are cited in such a connection.

Attention is called to the fact that this is a divisional case of applicant's patent, on which has grown up a multitude of new commercial industries. The particular branch represented by this case is as radically new as all the others.

For the above reasons, seven new claims have been submitted. Some of these are specific, but others have been stripped down to the bare basic principles of the invention, in the hope that thus presented they will be more easily recognized and appreciated by the Examiner.

3. Claim 3 has been amended so that line 5 refers to the proper antecedent.

For all of the above reasons, reconsideration and allowance of all of the claims is respectfully requested.

Paper No. 6

Rejection, June 25, 1926

In response to the amendment filed June 23, 1926.

Additional reference:

Elworthy, 579,866, Mar. 30, 1897 (62-121).

1. Claims 3 and 7 are rejected for lack of novelty and invention in view of the Elworthy disclosure. All these claims call for is an insulated container enclosing solidified carbon dioxide and material to be cooled. This would be merely the broad substitution of carbon dioxide ice for water ice in the ordinary *in* box or shipping receptacle, a feature clearly anticipated by lines 96-100, page 2 of the Elworthy patent.

[fol. 393] 2. Claim 10 is rejected as indefinite in that there is no antecedent for "insulation" recited in line 8. It is suggested that "insulation" be inserted before *container* recited in line 3.

3. The remaining claims are allowable as at present advised.

Paper No. 8

Amendment, June 30, 1926

In the matter of the above entitled application, please amend as follows:

Claim 3, line 2, insert *vented* before "protective".
Claim 7, line 2, insert *vented* before "protective".
Claim 10, line 3, insert *insulated* before "container".

Remarks

The above amendment is based on an interview kindly granted applicant's attorney on June 29, 1926, with the Primary Examiner and the Assistant Examiner in charge of this application. During this interview, the pertinency of the references was discussed, particularly the patent to Elworthy. The amendment to Claims 3 and 7 clearly differentiates from the reference, since provision for the formed carbon dioxide gas release is positively included. The amendment to Claim 10 overcomes the formal objection cited in the last office action.

The claims in their present form were therefore indicated allowable.

Allowance is respectfully requested.

[fol. 394] Allowance July 12, 1926.

Paper No. 9

Amendment under Rule 78, July 16, 1926

On final review of the above entitled application, the following amendments are respectfully requested to be entered:

Claim 4, line 1 cancel "transportation package consisting of a"; line 2 cancel "packed"; line 5 change "insulated" to *separated*; line 6 insert *insulated by* after "and".

Claim 5, line 1 cancel "transportation package consisting of a"; line 2 cancel "packed"; line 5 insert *insulated by* after "and".

Entry recommended under Rule 78.

C. H. Shaffer, Examiner.

July 16/26.

Entry approved.

M. G. Moore, Acting Commissioner of Patents.

Remarks

The corrections to claims 4 and 5 are for the purpose of putting these claims in better form, and for removing unnecessary limitations.

[fol. 395] DEFENDANT'S EXHIBIT C

Artificial Refrigeration

(Written for Ice and Refrigeration)

Artificial Refrigeration

A Chronological Study of Its Development—Its Importance, Its Applications, Its Future

By Auguste J. Rossi, B. S., C. E.

[Continued from August Issue, page 93.]

From the latter part of the last century, from 1770 to the beginning of the present one, when chemistry, abandoning the empiricism of alchemy, began to be an exact science,

and the constitution of matter became gradually better understood, many gases, such as oxygen, nitrogen, hydrogen, ammonia, carbonic acid, etc., were isolated and studied, their nature or their composition determined, their properties ascertained. It was found that some of them, such as ammonia and carbonic acid, among others, could be liquefied and even solidified in certain conditions of pressure and temperature, and that the liquids thus obtained were the pressures over them, maintaining them liquid, relieved would return to the gaseous state (their ordinary form of existence as known) generating by this transformation a very intense cold. It was observed also that certain solid substances, such as chloride of silver and chloride of calcium, especially the latter, could, in some manner not very well understood, absorb a very large quantity of this gas ammonia. Not much more than theoretical deductions were made of these observations at the time, and little was it thought then that on them would be based the industrial methods which have been since applied to the production of artificial cold or ice in unlimited quantity, and for any purpose whatever.

Faraday's Experiment

However, Faraday made the following remarkable experiment: Taking a stout bent glass tube, AB, closed at both ends, be placed in one of its branches, A, before closing it, pieces of chloride of silver, which had been made to absorb ammonia gas to saturation and, heating the branch A, while the other branch, B, was cooled by being dipped in ice and salt mixture, he found that a liquid was condensing in the branch B; this liquid was liquefied ammonia gas. The explanation given at the time was the true one. The heat driving away the gas ammonia from the chloride of silver, and this gas finding no issue, made pressure on itself (the volume of gas thus generated being many times

that of the inside capacity of the tube AB), until the pressure thus produced, assisted by the cooling of branch A,

brought about the liquefaction of the gas itself by bringing closer together its elementary particles. This was demonstrating at once the possibility of liquefying a gas, such as ammonia, by pressure, but this was not all.

The lamp having been removed from the branch A, and this branch cooled in its turn, while branch B was exposed to the air, it was found that the liquid accumulated in the branch B immediately entered into ebullition and disappeared completely. In fact the volatile liquid ammonia began to give vapors by the cooling of branch A, and the pressure of these vapors and of these existing already in the tube being relieved by thus being absorbed anew, as fast as forming, by the cooled chloride of silver of the branch A, were exactly in the same condition as in the experiment of Leslie, but in this case, dealing with a liquid, the liquefied ammonia gas, much more volatile than water, the action was considerably intensified. No source of heat being present there to supply to the liquid ammonia that heat required and necessary to operate the change of state from liquid to gas, no other source at least than the inadequate one furnished by the surrounding air, it had to be borrowed for the greatest part from its own mass, and the temperature in branch B fell so rapidly and to such an extent that this branch was coated with a thick layer of ice by the freezing of the condensed moisture of the air on the cold side of the tube.

By introducing in the tube AB, in the branch A, or in a similar apparatus, certain substances capable of generating by their mutual reaction under heat or in the cold certain gases which would thus be confined and caused to make pressures on their own particles, Faraday succeeded in liquefying most of the gases known at this time. There was much in these experiments. It showed in a general manner the possibility of liquefying gases by pressure, or by pressure and cooling combined, and of using the liquids obtained for purposes of refrigeration. It showed also the possibility of alternately absorbing the gas, the vapors of [fol. 396] a very volatile liquid in a suitable absorbent, and expelling them by heat from this absorbent to condense the gas to the liquid state by the pressure exerted by the gas itself on its particles, promoting the operation by a suitable cooling, and then, by allowing the cooled liquid thus ob-

tained to vaporize spontaneously by absorbing its vapors as fast as formed, by the original absorbent properly cooled, to produce an intense artificial cold. It proved also that ammonia, among other gases which could be thus liquefied, was capable of generating a considerable amount of cold by the evaporation of the liquid obtained by its liquefaction; and that, if used in conjunction with a proper absorbent, ammonia could produce such an artificial cold in a somewhat continuous manner were the apparatus properly contrived for such purpose. Insignificant, industrially speaking, as were the immediate consequences of this remarkable experiment at the time it was made, it has formed the basis of a special method of producing industrial cold by substituting water for chloride of calcium as the absorbent for gas ammonia—water, which is much better adapted than a solid for a practical application, and which, as is well known, can absorb enormous quantities of this particular gas, as many as 1,200 times its volume at a temperature of 32 deg. F.

But furthermore, this experiment, even in the conditions in which it was carried at the time, and in which chloride of silver was used as the absorbent, has been employed in our days with only a modification of the apparatus, and substituting chloride of calcium for chloride of silver as a cheaper absorbent, in such a manner as to produce ice in limited quantities, it is true, but still on what may be called yet an industrial scale for family use. The machine used has formed the subject of an American patent, of which we shall have occasion to speak.

The principles involved in artificial refrigeration, simple as they may be, after all, imply, as we can see from the above, a thorough knowledge of the constitution of matter, of its properties in the three states under which it manifests itself—solid, liquid and gaseous—and until such studies had been perfected—until the accumulation of knowledge, researches, observations of many centuries had enabled the following generations to reap the fruits of the unceasing efforts of the learned in preceding centuries, it is not to be wondered at if it did not make any serious progress for a long time. Indeed, up to the beginning of the present century, only such most evident laws of nature as

could have been observed from times immemorial afford us examples of some efforts of application in this direction.

But even had such knowledge been acquired much longer before the lack of a handy, everywhere-ready mechanical power to obtain certain effects would have opposed a barrier to its development until the discovery of the remarkable properties of steam, of which the steam engine is the *resume*, were discovered. As is well known, the steam engine has had hardly one century of existence. The beginning of our present century, then, opens a new era, and discoveries followed each other in rapid succession in all the branches of human knowledge.

We have seen that substances known to exist only in the gaseous state at the ordinary pressure and temperature of the atmosphere were found to be susceptible of being liquefied and even solidified in certain conditions; water affords us an example of such substances which can assume the three states. The cohesion, the state of aggregation of the particles of a substance, goes increasing as it passes from the gaseous to the liquid state and from this state to the solid state. Gases expand readily, as we can observe, and at once in the atmosphere, and could not be kept in open vessels, while liquids may easily be retained in them, and solids do not require any envelope of any kind. Since heat vaporizes many liquids, it has a tendency to destroy this cohesion, and cold inversely must have, and has, a tendency to increase it. Pressure, by bringing nearer together the particles of matter, must act evidently in the same manner. From such observations easily made and controlled, as we have seen, by actual experiments, there was not a great effort required to conclude that, by both pressure and cooling combined, certain gases, if not all, could be liquefied, and this was proved by Faraday to be the case, as already stated, for a majority of the gases known at his time. Thilorier, later on, in an apparatus which bears his name, produced even as much as four pounds of carbonic acid in a solid state in one operation. The substances capable of generating carbonic acid gas, sulphuric acid and marble dust, having been introduced in a strong cast iron cylinder, very much like the apparatus used in our days for making carbonic acid water on a large scale, the gas, making pressure on itself in a special and distinct receptacle properly

cooled, became liquefied, and by giving issue to the liquid thus formed, by the opening of a cock and collecting the liquid spray in a hollow half sphere of metal, the cooling produced by the spontaneous evaporation of a part of the liquid in the air (by the relieving of the pressure), was so intense that it solidified the remainder into a white ball of snow. So depressed was the temperature of this snow that, though it could be kept in the hand for a short while, it produced soon on the hand the same effect as a red hot iron would, disorganizing the skin. It could remain for a certain time in that state, but soon passed again to the liquid state, and then disappeared as gas, a thermometer inserted in the ball registering —110 deg. F., 110 deg. F. below zero F.:

In this case no absorbent was used to absorb the vapors. It is obvious from these experiments that similar liquids, thus or otherwise obtained, can only be maintained in that liquid state by being confined under pressure in a closed envelope, otherwise they would instantly vaporize and return to their original and normal state of gas at the temperature and pressure of the air. Were then the pressure over them, while they are thus confined, to be mechanically relieved partly or completely so as to reduce it to that of the atmosphere or below, they would instantly vaporize and, if placed in proper conditions, their temperature would fall to a very low degree, considerably below 32 deg. F. for many, as they would have to borrow the heat necessary for this change of state from their own mass. In the case of carbonic acid a temperature of —110 deg. F. was thus reached. If now we conceive such a liquid, properly chosen, to be confined in a close metallic reservoir under pressure, and this reservoir to be surrounded by water at ordinary temperature, if, by a proper mechanical device such as an exhausting pump acted on by a steam engine, for instance, we relieve the initial pressure to any important degree, the liquid will enter into ebullition, will give vapors. The [fol. 397] heat necessary for this change of state having to be borrowed from somewhere, and no other direct source of heat being available, the liquid will supply it first at the expense of its own temperature and indirectly at the expense of that of the water surrounding the reservoir containing it. With proper proportions of the volatile liquid

and of the water surrounding it, it can be conceived that the temperature of this water may be caused to fall much below the freezing point in other words, that ice will be obtained. The water may be indirectly cooled by placing the reservoir containing the volatile liquid in a non-congealable bath, such as a strongly saturated solution of salt, in which bath molds containing the water to freeze would be immersed, but the operation of cooling proper, though still more indirect, would be exactly the same. Were such operation continued for a certain time in those conditions the reservoir containing the volatile liquid would, sooner or later, be emptied, and no more cold could be produced. But we know that a proper degree of pressure and cooling can liquefy the vapor, the gas, thus generated. If, then, our exhausting pump is so combined that, after having removed the vapors forming pressure over the liquid in the reservoir, it can compress them and deliver them as fast as aspirated in another vessel distinct from the reservoir, in a condenser properly cooled by running water, we readily realize that, under this double action of cooling and compression, the vapors will return to the liquid state reconstituting the original liquid, and that they will be maintained in that liquid state by the pressure thus created in this condenser. It is easy to conceive such an arrangement as would allow the return to the first reservoir of the liquid thus reformed in the condenser so as to supply over and over again the quantities evaporated. Such is the whole theory of the system of refrigeration by mechanical compression, as it is called in our days. The liquids chosen, the mechanical contrivances adopted, may vary, but the principle is the same.

(To Be Continued)

New Refrigerants

In 1889, Messrs. Tichborne, Parley & Purcell, of England, took out a patent for the "Utilization of Carbonic Acid given off during Fermentations," the patent covering the collection of the gases given off during fermentations in breweries, more especially, into proper receptacles, the alcohols and ethers being subsequently separated from the gases in a scrubber or by means of a spray of water, when

the gas is cooled and compressed to a liquid and stored. A company to utilize these by-products was formed, known as the "Brewers' and Distillers' CO_2 Co.," but when the company's shares were put on the market, a London financial paper rather threw cold water on the scheme, as a desirable investment, which of course precipitated a discussion of the patent's merits. Of this discussion one point raised in defense of the patent may be of interest, and that is the one dwelt upon by Percy R. Allen, 2 Victoria Mansions, Westminster, who says:

"Referring to this process, I would venture to suggest that one of the most important applications has been rather overlooked, and this is the use of CO_2 as the cooling agent in refrigerating cars for the transit of chilled meat, fruit and perishable articles. I have had a very considerable experience in mechanical refrigeration, and know from personal experience the trouble and annoyance arising from the use of ordinary ice bunker cars. As a matter of fact, the weight of ice required to stock a car starting from Kansas City or Chicago to the seaboard is a large percentage of the dead weight of the car, added to which there is all the inconvenience of melted slush, and consequent rotting of the bunkers, and, moreover, such cars are very frequently unable to obtain return freight, owing to the peculiarities of their construction. Now it seems to me that this CO_2 system lends itself most admirably to cold storage cars, as the drums holding the liquefied gas could be placed under the car and the piping arrangement placed flat against the sides or circles, with a great saving of dead weight and space, compared with real ice. There is no doubt that rapidly increasing development of the chilled meat trade in this country demands a really good system of refrigerating cars, and this would seem to lie in the direction I have indicated."

M. Ducretet has devised an apparatus which, by the expansion of liquid carbonic acid, produces quickly a fall of temperature to 70° or 80° below zero C. It consists of two concentric vessels, the inner of which contains in alcohol a serpentine metal tube which connects by a tube with two stop-cocks with the carbonic acid reservoir outside, and opening below into the spaces round the inner vessel in which are pieces of sponge saturated with alcohol. This

double-walled vessel is inclosed within a box. One stopcock is opened wide, the other slightly, carbonic acid passing through the coil like snow, and turning to gas with great temperature reducing effect. Any of it not vaporized in the coil is dissolved by the alcohol in the sponges, and finally the gas escapes through the tube passing through the outer box. The apparatus is called a cryogen.

Pipe Line Refrigeration

The advantages claimed for pipe line refrigeration over the older methods with ice may be epitomized as follows: "The direct expansion of a liquefied gas produces quicker freezing, and makes it possible to maintain a uniform, dry, cooling temperature. A ton of regulated dry refrigeration can be delivered through a pipe cheaper than a ton of ice can be delivered by a team, and a ton of melting ice will only do three-tenths as much of the work required as a ton of dry, regulated refrigeration. Ice can be made by this system at the same time that the plant is in operation for cold storage and pipe line work, making the cost less than by other processes. A dry atmosphere is one of the most essential conditions in preserving food, it being possible to preserve meat even in a warm atmosphere for an almost indefinite period, so long as it is kept dry. Water and vapor from melting ice or brine of a fluctuating coldness saturate the contents of ordinary refrigerating chambers. The damp air absorbs the odors of various dishes, and communicates them to each other, all of which is avoided by dry frigeration."

In Siberia the cold in winter is so intense that meat defies the butcher's knife, and some of the salesmen place their animals in fantastic positions before freezing them,

[fol. 398] temperatures of +40°, +20° and —25°, at 100 each. Table No. 6 will be transformed into:

Table No. 7.

Temperature to be maintained in room.	Condensing temperature.	Theoretic capacity of cylinder.	Effective capacity of cylinder.	Gross capacity of brine.	Net capacity of brine.	Net capacity of direct expansion.	Net commercial capacity of brine.	Net commercial capacity for direct expansion.	Net available capacity for brine	Net available capacity for direct expansion.
+40	+60	100.	99.3	96.4	96.28	99.37	92.54	97.38	92.49	96.45
+20	+80	100.	97.3	83.2	82.8	97.2	78.66	93.33	78.75	93.12
—25	+100	100.	86.66	62.81	60.82	85.67	54.74	78.8	58.42	83.2

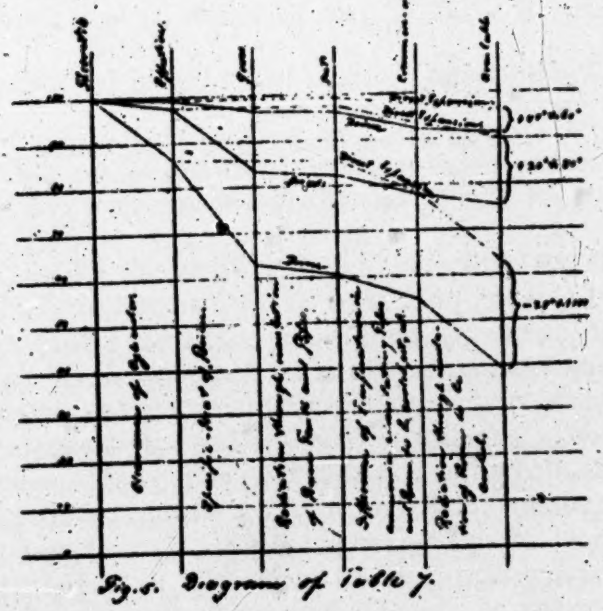


Fig. 6. Diagram of table 7.

Diagraphically, we demonstrate Tables 6 and 7 by the diagrams under the respective tables.

Low Temperatures

It appears that very satisfactory results have been reached in the experiments made with M. Caillette's apparatus for producing a temperature of from 90° to 110° F. below zero, by the expansion of carbonic acid. The ap-

paratus consists of two concentric vessels with a small annular space between them, a spiral coil being placed inside the inner vessel, and this is put in communication with a closed vessel containing liquefied carbonic acid gas. At its lower end the coil is connected with the annular space, and at its upper a stop-cock is fitted. When used, the inner vessel is filled with alcohol, the stop-cock on the carbonic acid vessel is fully opened, and the cock on the spiral partially opened, when the liquid passes slowly into the coil and takes the form of snow. From the coil it passes into the annual chamber, in which are placed pieces of sponge soaked in alcohol, which arrest all the acid that has not become gaseous, while the gas itself passes out of the apparatus through a bent tube. With about five and one-fourth pints of alcohol in the inner vessel, and consuming four and one-half to five and one-half pounds of liquid carbonic acid, a temperature of —95° F. can be obtained in a few minutes.

Reprint from Journal of Franklin Institute

A Computation of Joule's Equivalent

By R. H. Thurston

Some years ago the late Dr. Pliny E. Chase, then of Haverford college, published in the Journal of the Franklin Institute a series of articles of singular interest, and of curious result often, in which he traced what he called certain harmonies of nature, exhibiting some strangely related or oddly coincident physical laws and constants, and in which he deducted a number of remarkable conclusions. He subsequently published a short paper, reprinted in the Philosophical Magazine, in which he showed some reason for anticipating that it might utimately prove that the value of γ, the ratio of specific heats of gases, is simply the numerical quantity.

$$1 + \frac{4}{\pi_2} = 1.405285$$

(Phil. Mag., 1885, page 520)

It occurred to the writer to compute the value of J. the mechanical equivalent of heat, from this assumed value

of γ, taking the best values of constants determined by Regnault, referring all quantities to the air thermometer, and taking air as the gas to which the constants so selected should appertain.

From the well known equations deduced by both Rankine and Clausius, we have the equality,

$$C_p - C_v = R = \frac{\rho\sigma\tau\sigma}{T\sigma}$$

or the difference between the two specific heats is constant, a fact first pointed out by Carnot, and later proved by the modern methods of thermodynamics by the founders of that science. Since we take

$$\frac{C_p}{C_v} = \gamma$$

we have

$$C_p = J\,c_p = \frac{\gamma}{\gamma - 1} R : J = \frac{\gamma}{\gamma - 1} \cdot \frac{R}{C_p}$$

and taking as Regnault's most probable values of C and of R, in British measure, 53.37 and 0.2375, we have

$$J = \frac{1.405285 \,.\, 53.37}{.405285 \;\; 0.2375} = 778.12.$$

in foot-pounds, or 427 kilogrammeters per calorie. This corresponds to about 775 on the mercurial thermometer, falls within about one-eighth of 1 per cent of the value assigned to J by the British Association committee of 1876, and is somewhat lower than the figures obtained at the temperature of maximum density of water by Rowland in 1880. This determination would seem to lend some color of probability to the conjecture—for it seems to have been little more—of Dr. Chase. In further, and perhaps more satisfactory, confirmation of this, as at least a closely approximate value, as have the work of Dr. Röntgen, who, in 1872, obtained $\gamma = 1.4053$, as a mean of ten best observations. (Pogg. Ann., 1873, s. 580.) The probably most uncertain datum, involved in this computation is the value of R: but it is probable that all these figures are very accurate, and the computed value of J must be correspondingly so. Fur-

ther examination of the value of R, which involves the location of the absolute zero, is desirable, however.

The first year of Ice and Refrigeration is completed with this number. The subscriptions of those who began with Vol. I, No. 1, for one year, expire with this issue, and are now due for the second year.

[fol. 399] cannot have any bad effect on ice made of water so distilled.

Temperature for Produce

To the Editor:

What is the best temperature for carrying eggs, etc., in cold storage?

W. H. G.

Answer. The best temperature for eggs in cold storage is about 33° to 34° F., or, in other words, just as near the freezing point as they can be kept without freezing. In regard to turning the packages after they are stored, will say that this was formerly the practice, but we understand has been discontinued by the most experienced men in the business. The best season for putting eggs in cold storage is when they can be bought the cheapest. The most approved temperature for butter in cold storage was formerly thought to be from 34° to 38° F., but lately it has been found that it is better to freeze the butter solid.

Ammonia and Oils in Absorption Machines

To the Editor:

At what heat will any of the properties or atoms of aqua ammonia be destroyed? 2. Why is it that heat is not applied directly to ammonia in a boiler, as we do water? 3. Would it not do if applied in a form of boiler having a continuous and graded circulation with the necessary outlets for the generated gas? 4. Is there any oil that can be used as a lubricant in an absorption machine that will not cause it to boil or foam in the still? 5. Is there a process of making clear ice in cans without the use of distilled water?

P.

Answer. Apparently these questions are propounded with reference to the running of absorption machinery, and our answers are given accordingly.

1. The properties or atoms of aqua ammonia are not destroyed at any temperature that can be produced in an ammonia still, yet if the heating of the still is not conducted with care, much water may be carried over with the gas, thus tending to diminish the efficiency of the machine.

2. Heat may be directly applied to an ammonia still or boiler: in fact, it is done in some cases, but as a rule indirect boiling by steam seems to be preferable, as it can be regulated better, and is more convenient withal. Where efficient boilers are operated on the premises, it is probably also equally economical.

3. We have no doubt that the heating of an ammonia still or boiler, by direct fire could be greatly improved, by adopting boilers having a continuous and graded circulation, but we are unable to quote any particular instances of improvements of the kind.

4. All vegetable and animal oils are apt to become saponified in the presence of ammonia, and for that reason none of them are applicable for the purpose mentioned, and mineral oils, i. e., the heavy oils produced in the manufacture of petroleum, are best fitted for your purpose, but it is well to avoid excess in this case too.

5. In Vol. II, No. 1, page 36, and Vol. II, No. 2, page 97, we have described some devices calculated to accomplish this object, among which you may be able to find something that will meet your approval.

The suit of Chas. Haffcke against Eugene P. Clark, involving the refrigerator patent of Chas. Haffcke, was decided May 25, in the United States Circuit Court of Appeals, Baltimore, in favor of the appellant.

The tubular boiler of the Consumers Ice Co., New Orleans, exploded June 25, killing two men, one a negro who was passing the building, and F. B. Lee, an attorney, and injuring fourteen others, three fatally, including Fred Mathise, coal passer, who died next day, and others of the employes in the boiler room. The damage to the building

is estimated at $10,000, insurance, $25,000. The boilers were recently inspected and pronounced all right.

(Written for Ice and Refrigeration)

Production of Extremely Low Temperatures

The Difficulties in the Way of Obtaining Very Low Temperatures—The Inadequacy of Existing Machines for the Purpose—To Liquefy Oxygen

By Auguste J. Rossi, B. S., C. E.

If with the means we have now at our disposal, with the improved refrigerating machines of our days, it is possible to obtain readily such temperatures as are well adapted to make ice economically on as large a scale as can be desired, and if, taking into consideration the magnitude of the industries involving the use of artificial ice or cold, the first cost of the machine has become a secondary factor, the question is not the same when extremely low temperatures, such ones as —100° F., have to be produced and maintained. Still there exist conditions in which the reaching of such an intense cold becomes a necessity. Not only is this true for such researches as are of a mere technical and scientific character, but there are certain industries of a special nature, though of a limited importance, for which the production of such low temperatures imposes itself as a condition of success. The ordinary ice machines would prove entirely inadequate in such cases, even would not their cost exclude them for such purposes, a cheap and simple small ice machine being still a desideratum.

At the temperatures required in these special cases alluded to, the point of congelation of the volatile liquids themselves, such ones as sulphurous deoxide, or ammonia, would be reached, or nearly so; and, long before such ultimate temperatures would have been obtained, the working and efficiency of the machines would have been impaired. Sulphurous chloride solidifies, at atmospheric pressure, at a temperature of —105° F. and ammonia at —103° F. Air machines could certainly furnish, by the expansion of cooled compressed air, temperatures as low as these, but they cannot be thought of for purposes of experimentation

or practical production of cold for small industrial purposes, on account of their first cost and the installation they require.

Ethylene (olefiant gas) has been proposed and used for such purposes, and Mr. Cailletet, by the use of a compression pump provided with a mercury piston, has been able to obtain liquefied ethylene in sufficient quantities for many applications. The gas liquefies at a temperature of —102° C., about —150° F., at the atmospheric pressure, and can be condensed to the liquid state at a temperature of 50° F. under a pressure of sixty-three atmospheres, about 915 pounds per square inch. The liquid ethylene boils at —108° F. (—78° C.), under a pressure of four to five atmospheres (seventy to seventy-five pounds per square inch); and it requires 42½ atmospheres, about 616 pounds per square inch, to liquefy it at 32° F. Evaporated in vacue liquid ethylene can furnish a temperature of —136° C., nearly —243° F. When the liquid is allowed to escape from the carboy in which it is confined, the evaporation of the liquid and the expansion of the gas generate such a cold that a part of the liquid itself becomes solidified. Its use is attended, however, with certain difficulties.

Mr. Olszewski, repeating the experiments of Pictet and [fol. 400] Cailletet on the liquefaction and solidification of some of the "so-called" permanent gases, such as nitrogen and oxygen, has found that, while to solidify nitrogen a temperature of —214° C., about 353° F., and a pressure of sixty millimeters of mercury were required, the critical point of nitrogen was indeed only at —146° C., under thirty-five millimeters of mercury (760 millimeters of mercury represent the normal atmospheric pressure.) Andrews has found from numerous experiments with gases that for any given gas a certain temperature may be reached above which this gas cannot be liquefied, however much the pressure may be increased; it is this temperature which is called after him the "critical point" of a gas.

Mr. Olszewski has found that, under a pressure of four millimeters of mercury and a temperature considerably less than —211° C. (—348° F.) oxygen gas liquefied does not solidify. Liquid oxygen would be then certainly the best of all refrigerants for the purpose of obtaining extremely low temperatures. Oxygen gas has been liquefied and can

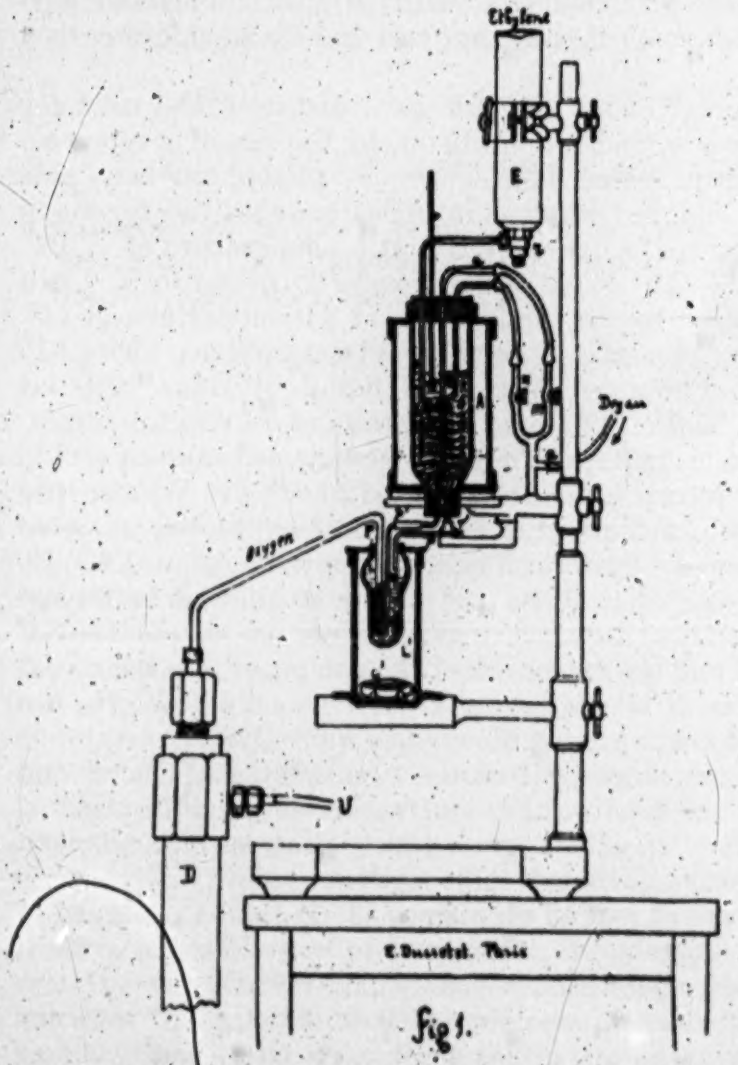


Fig 1.

even be supplied in that state in good amount. The apparatus used for such purpose has been conceived by Mr. Cailletet, and we will briefly describe it as it has been constructed by Mr. Ducretet, of Paris, for purposes of experimentation.

The liquefaction of oxygen gas is obtained by means of liquefied ethylene rapidly evaporated by passing through it a current of dry air. A Cailletet pump—that is, a pump provided with a mercury piston—was used to liquefy first the ethylene which was stored in a reservoir in metal E, provided with a proper cock r. This reservoir, or carboy,

E., is connected with a coil S, in metal, inclosed in the vessel R, contained itself in an outside vessel A, forming an envelope to avoid loss of cold by radiation. At its lower end this coil S projects and extends through the bottom of the vessel R, where it is closed by a cock r. By means of the pipe a, which penetrates in the vessel R at the top, extending nearly to the bottom, air previously dried by being passed through calcium chloride, or in any other manner, can be blown, when required, in the vessel R.

Dry air can also be blown, by a proper regulation of the cocks m, n, of the admission pipe a, which is forked for such purpose, through a second coil S, concentric with the first coil S, and, like the latter, contained in the vessel R.

This coil S projects out also through the bottom of R and the two outside projecting pipes p, p′ of the two coils S, S′ enter the vessel L, which is contained in another one, L′, forming an air insulation; the air of the annular space being kept dry by means of sulphuric acid contained in a proper vessel C. The pipe p of the coil S reaches but to a short distance from the top of vessel L, while the pipe p′ of the coil S′ reaches down almost to the bottom of this same vessel L, which is open freely at the top. In the vessel L penetrates also, nearly to the bottom, a sort of small cylindrical reservoir of strong glass, P, closed at one end, which is connected with the strong metallic reservoir or carboy D, in which is the oxygen contained in a proper vessel or tube of glass.

The apparatus is worked in the following manner:

Methyl chloride is first poured in the vessel R, where by its spontaneous evaporation the temperature soon falls to —23° C. (—9° F.). By blowing dry air through tube a, cock m being opened and cock n closed, the temperature soon falls in R to —70° C. (—94° F.) The cock r of the ethylene carboy being thus opened, the liquid ethylene fills the coil S of which the cock r′ is closed, and is there cooled to about —94° F. The cock r′ of the coil S being thus opened, the cold ethylene flows freely in vessel L which it fills to a proper level, regulated by the proper opening of cock r′, with liquid ethylene at —94° F. Air being now blown through pipe a, after closing cock m and opening cock n, the air, cooled in vessel R by its passage through the coil S′, immersed in cold ethylene at —94° F., evapo-

rates freely the cold ethylene of L, and the temperature of the liquid falls down further yet in L, soon reaching —125° C., (—193° F.). The carboy D containing the oxygen being then connected with a compressing pump by means of the tube U, the pressure rises over the gas contained in D, and when it reaches fifty to sixty atmospheres (750 to 900 pounds per square inch, about) the oxygen contained in the glass reservoir or tube P immersed in the cold ethylene of vessel L is liquefied to a colorless liquid.

Such are the principal features of the apparatus as used for experimentation, but which, obviously, can be enlarged by proper modifications so as to obtain important amounts of liquid oxygen which can be stored in strong vessels to be used for the production of the most intense cold. It is [fol. 401] obvious also that, to obtain large quantities of such a liquid in this manner, it would prove somewhat expensive and, at least for the present, that it could not be used for applications on a certain scale. The storing vessels have to stand an enormous pressure. Such an apparatus could be used to obtain low temperatures without liquefying oxygen. But we have at our disposal a liquid which, though not capable of producing such extremely low temperatures, can give us readily temperatures of —100° F., possessing beside the advantage of being obtainable currently at a low cost, liquid which it has been even proposed to use in an ice machine on an industrial scale. This liquid is liquefied carbonic acid gas.

It has been prepared for the first time as liquid on a really industrial scale in Germany, though its properties as a cold producing agent, and even its preparation in that liquid state, have been known and practiced for years in laboratories. Dr. Raydt, of Hanover, had used it as early as 1879 for a novel purpose: that of floating a sunken German ironclad, the "Gosser Kurfurst," sunk by a collision in the channel. In a preparatory experiment made by Dr. Raydt with something like ninety pounds of liquid carbonic acid, an enormous amount of gas was produced which, being filled in impervious, strong canvas bags, was sufficient to raise to the surface of the water the enormous weight of sixteen tons! Since then liquid carbonic dioxide has been currently manufactured in large quantities. Its property of producing a great lowering of temperature by

its evaporation has been made use of, at the Krūpp works, for certain specific purposes in the manufacture of ordnance. Even as early as 1887, something like a ton of liquid carbonic acid was manufactured daily in Berlin, for many applications, being currently used, for instance, for the preparation of carbonic acid waters. It is stored in forged iron vessels capable of resisting to a pressure of 250 atmospheres. In 1887 more than 10,000 of such cylinders, containing about fifteen pounds of the acid each, had been sold to the trade. It has been used extensively also for forcing the beer out of the barrels and raising it from the cellars, relieving the stale taste of beer which has remained too long in an open barrel. The opening of a cock in the carboy is sufficient to let the gas escape, or, if it is inverted, to allow a jet of liquid carbonic acid to escape, which, by its spontaneous evaporation in the air and expansion, produces such a lowering of temperature that it solidifies a part of the liquid mass in the form of a snow-like substance. This snow can be readily kept for as long as twelve to fifteen hours in woolen cloth; it vaporizes gradually, returning to the gaseous state and producing an intense cooling effect by this double change of state, from solid to liquid and from liquid to gas; 200 of liquid carbonic acid can furnish nearly 100 of snow. Carbonic acid gas, as is well known, is readily produced by the decomposition of limestone, chalk or any carbonate by a strong acid. If, in this gaseous state, it is compressed and cooled in a condenser it can be liquefied in the same manner as gaseous ammonia or sulphurous dioxide are in an ice machine, only the pressures required are considerably greater and, as is the case with the two preceding volatile liquids just mentioned, these pressures vary with the temperature of the condensing water.

Liquid carbonic acid has a specific gravity almost equal to that of water at a temperature of 14° F. It is .947 at 32 F. Its boiling point is at about 108° F., at the pressure of the atmosphere. Its tension at 13° F., is of about seventeen atmospheres, 255 pounds per square inch; at 77° F., of about sixty-six atmospheres, nearly 1,000 pounds per square inch. Mixed with ether, when the mixture is brought into the vacuum of an air pump, the temperature sinks down to —110° C. (—166° F.). A tube of liquid car-

bonic deoxide brought into this solidifies to a transparent ice-like solid mass. The specific gravity of the gas is nearly 1.50, air being 1. The latent heat of evaporation of liquid carbonic acid has not been exactly determined, that we are aware. By direct experiments we have found it to be approximately 250 thermal units per pound.

[To be Continued]

Beef Trade Statistics

The number of cattle slaughtered in the chief packing centers of the United States for the year ending March 1, 1892, was as follows:

	1891-92	1890-91	1889-90	1888-89
Chicago	2,425,000	2,680,000	2,206,000	2,032,000
Kansas City	523,000	516,000	433,000	367,000
South Omaha	347,000	316,000	251,000	145,000
East St. Louis	195,000	177,000	125,000	50,000
Sioux City	27,000	18,000	11,000	25,000
Milwaukee	16,000	13,000	12,000	.....
St. Paul	10,000	10,000	11,000	.....
Cleveland	41,000	.....	.....	.....
Total	3,584,000	3,730,000	3,049,000	2,619,000

The total receipts of cattle at the four prominent seaboard cities, New York, Boston, Philadelphia and Baltimore, with the exports of cattle from the United States, almost wholly represented by these ports and the remaining supply, for twelve-calendar years, were as follows:

	Total receipts	Exports	Remaining
1880	1,267,000	216,000	1,051,000
1881	1,145,000	142,000	1,003,000
1882	1,015,000	75,000	940,000
1883	1,166,000	175,000	991,900
1884	1,011,000	147,000	864,000
1885	961,000	137,000	824,000
1886	899,000	117,000	782,000
1887	805,000	106,000	699,000
1888	1,043,000	155,000	888,000
1889	1,214,000	329,000	885,000
1890	1,280,000	417,000	863,000
1891	1,189,000	300,000	859,000

The exports of beef from the United States for the twelve calendar years ending with 1891, in pounds, were as follows:

	Fresh	Salted	Canned	Total
1880	101,000,000	46,000,000	71,000,000	218,000,000
1881	97,000,000	43,000,000	48,000,000	188,000,000
1882	54,000,000	41,000,000	38,000,000	133,000,000
1883	118,000,000	46,000,000	34,000,000	198,000,000
1884	117,000,000	38,000,000	33,000,000	188,000,000
1885	108,000,000	70,000,000	41,000,000	219,000,000
1886	94,000,000	36,000,000	42,000,000	172,000,000
1887	80,000,000	42,000,000	43,000,000	165,000,000
1888	106,000,000	51,000,000	45,000,000	202,000,000
1889	171,000,000	73,000,000	72,000,000	316,000,000
1890	182,000,000	110,000,000	105,000,000	398,000,000
1891	203,000,000	72,000,000	86,000,000	361,000,000

An ice dealer at Alexandria, Va., when told by a newspaper reporter that the people were complaining about the price of ice, said he "was not selling ice for amusement, but for profit: that he lost $800 in the business last year, and did not propose to repeat it." If Alexandria were Chicago, or New York, say, the ice man might have replied, "Oh, well, elect me alderman, and you can all have ice for nothing."

[fol. 402] [Written for Ice and Refrigeration]

Production of Extremely Low Temperatures

The Difficulties in the Way of Obtaining Very Low Temperatures—Ducretet's Apparatus for Producing Extremely Low Temperatures with Liquid Carbonic Acid

By Auguste J. Rossi, B. S., C. E.

(Concluded from July Issue, Page 32)

For many purposes of industrial extreme refrigeration, the carbonic acid liquid seems to be well adapted. It can be safely handled. In Europe no accident has ever attended its use; and as early as 1887, as we have said above, more than 10,000 cylinders had been furnished to the trade. It is cheap; it has no pungent odor; and used in the air of in a ventilated room, it cannot have any injurious effect. It does not in any way corrode the metal of the vessels used to store it; it is not only uninflammable, but is, on the contrary, a perfect fire extinguisher; in fact, many portable apparatuses to put out fire are based, as is well known, on its use as the active agent for the extinction of flames. We

were consulted, a few months ago, by certain parties wishing to experiment with particularly delicate essential oils, very expensive. It was necessary for the requirements of this industry, to be able to maintain in a liquid mass, weighing from three to four pounds, a temperature as low as —80° F. for one hour or two. This amount of three to four pounds represented, in fact, about the fourth of the total production of a day, the product in this condensed form having a very high value per pound. We advised the parties to use the apparatus conceived by Mr. Cailletet for the use of liquid carbonic acid. The apparatus which we are going to describe is much simpler than any yet suggested for limited use, and has proved very successful in France, where it is constructed by Mr. Ducretet, of Paris, from the indications of its originator, Mr. Cailletet. Though limited in size, it is as effective, as we have had occasion to ascertain, as it is ingenious and cheap. As will be seen from the following description, the apparatus could be considerably increased, and, for many practical purposes, would prove very useful. It is intended to produce and maintain temperatures of —70° C. to —80° C. (—94° F. to —112° F.). The principle of its action is the expansion and evaporation of liquid carbonic acid. As already stated, this liquid carbonic acid can be readily procured in small new cylinders containing some 15 pounds of the liquid, at a cost of fifteen to twenty-five cents per pound. There cannot be any doubt that, were there to be a demand for such liquid, it could be bought at a much lower price. We believe it has been lately manufactured in this country, but the prices we have just quoted refer to liquid carbonic acid imported from Germany, where it was first manufactured on a large scale, and these prices are those we have actually paid for it in New York, using only limited quantities of the liquid.

The apparatus, as constructed, by Mr. E. Ducretet, of Paris, consists essentially of two concentric cylindrical vessels R R′ of nickel plated copper, leaving between them an annular space of a few inches. The inside vessel R contains a coil pipe S of nickel plated copper, of about one inch in diameter. This coil S is provided with a regulator-of-pressure cock O at its upper part, its lower end Q opening in the annular space M between the vases R and R′. This

cock O is connected with a strong iron pipe which, by means of lock nuts, or any other appropriate contrivances, can be

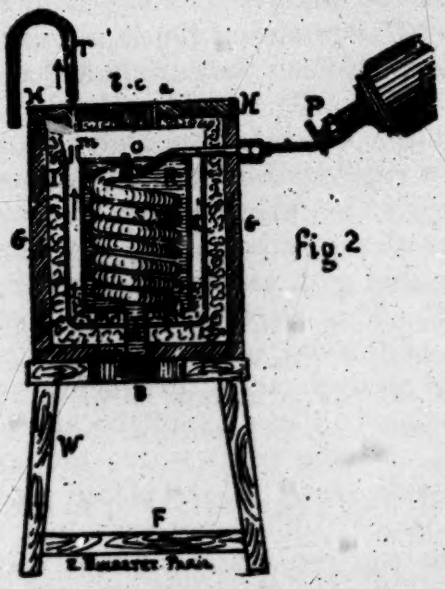


Fig. 2

connected, in its turn, with the outlet pipe of the iron carboy C containing the liquid carbonic acid. A metallic sleeve A extends through the bottom of vessel R and the annular space M, projecting outside of the wood standard of the apparatus W, where it is closed by a proper obturator B. This sleeve is used only in special cases, when certain liquids have to be condensed in vessel R. In such cases these liquids running out from said vessel, as they are condensed can be collected in proper bottles or vessels, placed on the shelf F which is provided for such purpose between the legs of the standard W. The whole apparatus is fitted in a wooden box b in which proper insulating materials I are packed between the sides of b and the vessels R R'. This box b receives a cover H which is also well insulated by proper materials. The openings a, b, c in the cover H are intended, a to receive a thermometer to be dipped in the liquid; b, to allow of reaching the cock O of the coil, so as to work it when necessary, and c to introduce any stirring tort, or agitator, as may be found proper, in case such stirring should be required.

To operate the apparatus strong alcohol is filled in the vessel R, of which the capacity, in the model that we re-

produce, is about of one gallon of liquid room. This alcohol is intended to act as a refrigerating bath during the operation. The coil pipe S is then put in communication with the carboy C, containing the liquid carbonic acid, by opening full the cock P on the carboy and only in part the cock O on the coil S. The liquid carbonic acid penetrates in the coil S, and, entering immediately in vapors, the cold produced by the vaporization and the expansion is such as to actually solidify the carbonic acid, which enters the coil in a state of a soft snow-like substance which the pressure forces through said coil, causing it to reach down to the outside vase R′. This snow, in contact with the warmer [fol. 403] sides of the coil, passes again to the liquid state, and then to the gaseous state, producing an intense cold which is transmitted by contact to the alcohol bath of the inside vessel R. At the point where the coil S opens in the annular outside vessel R′ are placed pieces of sponge, saturated with alcohol. Whatever snow may not have been vaporized in the coil penetrates R′, where it is dissolved in this alcohol, producing an additional cooling effect. The gaseous carbonic acid produced finally escapes at m and from there into the tube T which opens in the air. This tube T can be dispensed with. In this case, the cold gas escaping through opening m fills the upper part of the apparatus before it can finally escape in the air through the openings of the cover.

The apparatus can be so constructed as to have a circulation the reverse of the one we have just described. That is to say, the carboy can be so connected that the liquid carbonic acid it contains may be made to penetrate first in a snow state through the then closed annular space of the vessel R′ and then penetrate at N in the coil S, vaporizing there and producing an intense cold, the gas generated being allowed to escape finally at the upper part of the coil, which in this case, not being connected with the carboy, opens, on the contrary, in the open air. The expansion cock O may become obstructed in some manner by the solidification of the snow of carbonic acid, but it soon clears itself alone after a short time. To promote this it is advisable to close and open gently successively this cock O with the wrench used to operate it from the outside. It is not necessary to let a great quantity of carbonic acid into the ap-

paratus, and the expansion cock should be but partly opened, and that slightly during the operation.

In a few minutes the temperature of the alcohol bath (about one gallon) is found to fall to —70° C. (—94° F.), with an expense of about five pounds of liquid carbonic acid. When the communication is closed with the carboy, if the apparatus is properly insulated, the temperature of the bath does not rise but very slowly. In experiments made with such an apparatus in France, after nine hours, the temperature of the alcohol bath was found to have risen from —94° F. to —10° F., or thereabouts. If, from time to time, the cock of the liquid carbonic acid carboy is opened anew and a fresh quantity of carbonic acid introduced, it is possible to maintain, for an indefinite time, a very low temperature which remains constant for hours.

This apparatus, as can be seen, is of an extremely simple construction; can be put up cheaply; and, we are convinced, could be used on a much larger scale for the production of intense cold in special cases not easily attainable with ordinary ice machines without a great cost, even if it could be obtained. It would dispense with the putting up and running of even a very small ice machine, could such a one be built cheap enough. We even believe such an apparatus to have still greater possibilities. We have suggested the use of this apparatus to parties who intended to make extracts from certain substances of an essential oil, which could only be condensed, without losses in quality and flavor, at very low temperatures, one not higher than —30° F. It was necessary also to freeze out any water which might be contained in the condensed products. The products of the concentration were intended to be received in suitable vessels placed in the alcohol bath, and being condensed there readily and quickly and the water eliminated, the purified oil could be collected through the sleeve and into the vessels intended to store it in. In experiments carried on by us for certain researches, the operation proved economical, rapid and entirely successful, and still the apparatus used was but a crude one compared to those constructed by Mr. Ducretet. It embodied only the principles laid down by Mr. Cailletet.

That such an apparatus could be constructed cheaply on a much larger scale is obvious to any engineer familiar with the working of an ice machine. It appears to us to solve completely the problem of the obtaining of very low temperatures for certain specific purposes as long as temperatures of —100° F. are considered as sufficient; and, in most cases, such temperatures are certainly all that can be required.

Prof. Wood's Table

In the issue of Ice and Refrigeration for February, 1892, in an article on "Ammonia," Prof. Siebel reprints Prof. De Volson Wood's table of "Physical Properties of Saturated Ammonia," which will be found also in its entirety in Prof. Wood's work on "Thermodynamics," pp. 462, 463 (fourth edition, 1891. John Wiley & Sons, N. Y.). Subsequently, Mr. Geo. Richmond in his series of articles on "Compression Machines," published in Ice and Refrigeration, called attention to some slight errors in the calculations, which fact having been brought by the editor to Prof. Wood's attention, he caused a recalculation of the table to be made under his immediate supervision, the results being revised and verified by him. These revisions Prof. Wood expected to make public some time ago. The reasons for the delay will be seen below, in a letter to Ice and Refrigeration noting the results of the revised calculation, which he has kindly sent to this paper in advance of their publication in the contemplated fifth revised edition of his book. Prof. Wood says:

"My computer did not finish the computations for the ammonia table before the close of our year [in the Stevens Institute of Technology, Hoboken, N. J.], and then my hold on him ceased. I have, however, revised three important columns, and find only one set of errors that will be noticeable; those opposite —5° F. absolute. Instead of

—5	455.66	3968.0	27.57	.....	9.89	0.0244	.1011

they should be—

—5	455.66	3877.2	26.93	.....	10.10	0.0244	.0990

[In reprint in Ice and Refrigeration, Vol. II, page 110, the second column in above correction was omitted. Conf.

corrections with table as reprinted or original in "Thermodynamics," citation above. The following correction also should be compared with the tables in the book, and not in Ice and Refrigeration.]

"Also, in column $\frac{1}{v}$, for 0.1094, read 0.1111.

"There are a few errors in the last, or right hand, figures, but they do not affect the result by more than one per cent, and these in only a very few cases."

Prof. Wood adds that he desires to himself extend the table to about 140 degrees (it now covers only 100 degrees), and when he shall have done so he promises to favor Ice and Refrigeration's readers with a copy of the computations.

[fol. 404] We append below the most important new patents relating to the ice, ice making, refrigerating, cold storage and kindred trades that have been issued from the patent office during the past month, reported expressly for Ice and Refrigeration:

Ice Making Apparatus

No. 533,035. William L. Church, Newton, Mass., Assignor to the Westinghouse, Church, Kerr & Co., Jersey City, N. J., and New York, N. Y. Filed March 17, 1894. Serial No. 504,049. Patented January 29, 1895. (No model.)

Claim.—1. In an ice making apparatus, an ice sha-ing tank comprising a freezing bed having an acting surface of conducting metal through which heat is conducted to the

refrigerating agent within the bed, and a wall which is separable from the bed and presents a portion of its sur-

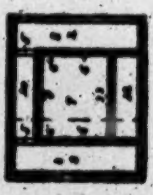
face to the said acting surface of the bed, so that a film or packing of ice is quickly formed between the said surfaces.

2. In an ice making apparatus, a freezing bed composed of pipes or conduits and casings or sectional headers connecting the ends of said pipes, said casings presenting an exposed vertical face or acting surface, combined with a wall which is separable from said bed and presents a portion of its inner side to said acting surface.

Refrigerator Shipping Box

No. 533,794. Thomas Drummond, Chicago, Ill., Assignor to George T. Cook and W. W. Rathborne, same place. Filed February 10, 1893. Serial No. 461,795. Patented February 5, 1895. (No model.)

Claim.—1. A refrigerator shipping box or case, comprising in combination a box or case, the end walls, 2, of which

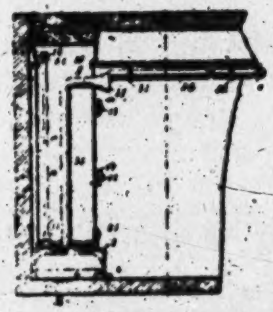


are formed with the pair of vertical grooves 5, a pair of vertical partitions 6 removably placed therein and made a less height than the interior of the box, and a cover 9 inclosing the central chamber formed by such partition, substantially as set forth.

Refrigerator Car

No. 532,651. John H. Dyerson, Kansas City, Kan. Filed October 17, 1893. Serial No. 488,399. Patented January 15, 1895. (No model.)

Claim.—In a refrigerator car the combination of the benches formed in a single piece having one foot secured to the bottom of the car outside of the drip pan, and having the other foot resting on a block at the end of the car, angle irons secured transversely on the benches, tanks for



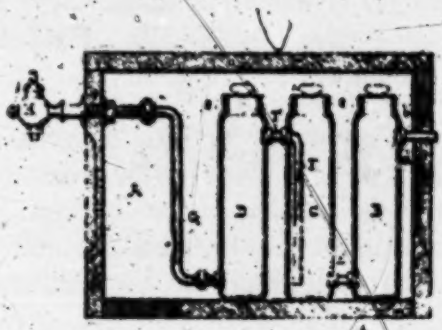
holding a refrigerant supported on the angle irons, rods extending across the car and resting in collars secured by screws to the sides of the car and blocks between the tanks and the sides of the car to support the tanks in such manner as to provide ventilation and circulation of the air between the tanks and the sides of the car, substantially as shown and described and for the purpose set forth.

Beer Cooler

No. 532,552. Edward L. Hall, Baltimore, Md. Filed March 15, 1894. Serial No. 503,696. Patented January 15, 1895. (No model.)

Claim.—In a beer cooler, the combination of an ice box, a series of cylinders or jars with air tight covers, the first jar of the series being furnished at its upper end with a pipe leading to a supply of beer under pressure, and connected at its lower end to the lower end of the second jar of the series by a horizontal pipe, and the last jar of the

series connected to the adjacent one by means of a pipe which leads from near its top to near the bottom of the



said adjacent one, and a pipe with a drawing faucet leading from the bottom to the last of the series of jars, substantially as specified.

Reversible Handle for Refrigerator Doors

No. 532,922. John W. Suetterle, Milwaukee, Wis. Filed November 23, 1894. Serial No. 529,694. (No model.)

Claim.—1. In a fastening device for refrigerator doors, the combination with a handle latch and handle supporting shank formed integral, of a fastening plate provided upon its front or outer surface with an annular spring inclosing

housing or flange, and a central shank supporting sleeve, and upon its rear surface with a stationary stop adapted to engage against the shank retaining key, and limit the turning movement of the handle, as set forth.

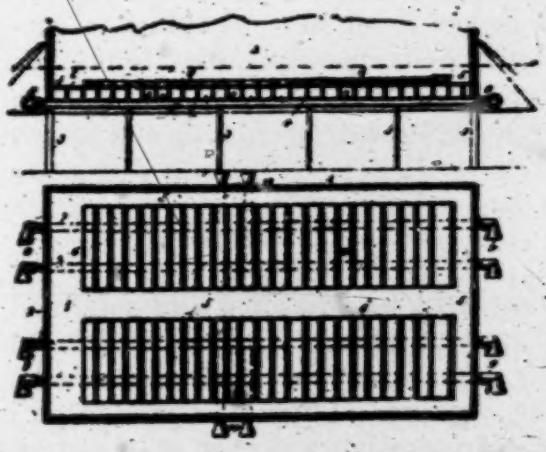
3. In a fastening device for refrigerator doors, the mechanism for reversing the position of the handle, and latch from one side to the other of its retaining plate, without turning such plate, consisting in the combination with the

handle retaining shank provided with two key retaining apertures arranged at right angles to each other, and with the rear surface of said fastening plate of a key and key stop or lug adapted to arrest the movement of said key and shank from either side, all substantially as and for the purpose specified.

Apparatus for Manufacturing Ice

No. 532,921. John P. Stromberg and Carl E. Stromberg, Essex, Iowa. Filed September 11, 1893. Serial No. 485,277. Patent January 22, 1895. (No model.)

Claim.—The combination with a platform supported on legs within an inclosed space and provided with transverse



strips having air spaces between them, of shallow metallic pans supported on said transverse strips, and perforated pipes having air funnels at their projected exposed ends, and perforations in their upper sides intermediate of said transverse strips, as specified.

[fol. 405] — got the ice puller, rigged up the hoe on a piece of pipe, and pulled this back floor down, and inside of one hour the boiler was steaming in "great shape." As I started away, the fireman, an old negro, said: "Boss, I am glad you took all that mess out of this furnace, and I wish you would change those grate bars. I knew what was the

trouble. I used to fire this boiler before, and it never behaved as it does now." I have seen a good many boilers set like No. 1; a lot like No. 2 and many like No. 3; but where any of those settings were found I always found a coal bill to correspond.

I have found a good many like No. 4, and with them I have never failed to find small coal bills, always a good fireman, a pleasant employer and a first-class good man in charge as engineer. And, best of all, the business was paying nicely. And, further, the writer; in the case above, after getting out a sufficient quantity of earth and brick from under the boiler set like No. 1, did burn the coal that had been thrown out into the yard, and reduced the coal bill from 5,400 to 4,500 pounds per day for a 10-ton machine. I believe where boilers are taxed to their fullest capacity, the distance should be thirty inches instead of twenty-four inches from bars to boiler. This distance I think would give better results. Fronts that are made for a 24-inch drop could be made thirty inches by changing the bearer bar like sketch marked No. 6, and by making liners to suit

Solid Carbonic Acid

Dry carbonic acid was distilled and solidified in a wide refrigerated tube in which a thermometer had been introduced axially. The melting point of the solid acid was —56.7°. The pressure at the time was 5.1 atmospheres. The point of refrigeration was then observed and found to be —56.7° at the pressure of 5.1 atmospheres. This result agrees substantially with the figures found by Faraday. The point of ebullition of solid carbonic acid is at —79°. Regnault found —78.16, and Pouillet —79°. Ether mixed with solidified carbonic acid (carbonic snow) does not reduce the temperature. Methyl chloride behaves quite differently. Setting out from —65°, the carbonic snow dissolves without liberation of gas, and at the moment of complete saturation the thermometer marks —85°. The lowest temperature reached by means of carbonic snow in racuo is —115°, a point which was maintained for nearly three hours.—P. Villard and R. Jarry.

An item is now going the rounds of the newspapers crediting to Professor Craig, of the Canadian experimental farm at Ottawa, Canada, the following remarks: "Before long you will see a revolution in the apple trade. Winter apples will not be a necessity. Cold storage will solve the difficulty. Probably before two years are over you will see in every fruit growing district cold storage houses on the co-operative plan, based on the cold storage buildings at the World's Fair. Fall apples put into cold storage buildings where the temperature is 34° may be kept an indefinite length of time. Thus winter apples will not be necessary. When I was at the World's Fair in the middle of the hot season I saw in good condition Duchess of Oldenburg apples which had been ripened early the previous summer and kept in cold storage. While in Montreal recently I noticed in the new cold storage buildings beautiful California pears."

Frozen Milk

Canada's representative in Denmark reports that during the past year a new industry has been established there, which promises to prove both profitable and serviceable, and which might be followed with equal success on this side of the water, viz., the shipment of frozen milk to large cities.

A year ago a Danish merchant experimented in this direction by taking Danish milk, which is peculiarly delicate and rich in flavor, freezing it by the use of ice and salt, and sending it in barrels, by rail and steamer, to London. On its arrival the milk proved to be as sweet and well tasting as if it had been just drawn from a cow in the middle of Sweden.

The milk was so much in demand and proved so profitable an article of commerce that the exporter immediately took out a patent on the shipment of frozen milk from Sweden and Denmark to London. He then sold the patent to a stock company with large capital, which on February 1, last, bought one of the largest Swedish creameries, converted it into a factory, and having put in a special freezing apparatus, began on May 1 the export of frozen milk in large quantities.

When the milk is received from the farmers it is pasteurized, that is, heated to 75° C. (167° F.), and then immediately cooled off to about 10° C. (50° F.), and now the freezing is commenced. Half the milk is filled into cans and placed in a freezing apparatus, where it will be thoroughly frozen in the course of three hours. The frozen milk is then filled into barrels of pine, the only kind of wood that can be used. The barrels, however, are only half filled with this frozen milk, the balance being filled with the unfrozen milk.

This way of packing has proved to be the only practical one, as part of the milk has to be frozen in order to keep the whole cold, and part has to be in a flowing state in order to get the barrels exactly full, which is necessary in order to avoid too much shaking up on the road, by which the cream would be turned into butter; the floating masses of ice at the same time prevent the unfrozen milk settling in the cream. Milk which is treated in this way has proved to keep quite fresh for twenty-six days. Every barrel holds 1,000 pounds of milk, and twice a week there will be shipped fifty barrels, making in all about 100,000 pounds of milk a week.

The milk is shipped to Newcastle and from there by rail to large manufacturing cities, where it is sold in the streets or in retail stores. It is reported that the patent has been bought for Ireland also, at a cost of $200,000, which proves how much the stock company expects from this new enterprise.

The time may not be far away when the dairy farms of the New England and western states may be sending not butter and milk, but frozen milk and cream, to the large cities of both continents.

The storage in the cold room of woolens, silks, etc., has been in practice for some years; but in New York this season the demand for cold storage space has been rather greater than usual, for the care of underwear, etc., on account of the moths, which had become a pest in certain large wholesale houses. One large house became infested, and had to put the whole of their stock into the cold room, which is held at 22° F.

[fol. 406] [Adapted for Ice and Refrigeration]

The Liquefaction of Gases

Factors Governing the Liquefaction of Gases—History of Experiments in this Direction—Those by Davy, Faraday, etc.—the Methods Employed

By Vaughan Cornish, M. S., F. C. S.

The common liquids, such as water, rock oil, mercury, and so on, can be readily converted into gases; but many of the common gases, on the other hand, for instance oxygen, nitrogen and hydrogen, can only be brought into the liquid condition by the use of special methods and powerful agencies. Temperature and pressure are the two factors on which it depends whether a body remains in the state of gas or assumes the liquid condition. Low temperature and high pressure are the conditions favorable to liquefaction.

The history of experiments on liquefaction of gases is mainly a record of devices for producing high pressure and low temperature. Sulphurous acid gas is condensed at the temperature of an ordinary freezing mixture, or at the pressure which can be obtained by a hand-worked piston in

FIG. 6.

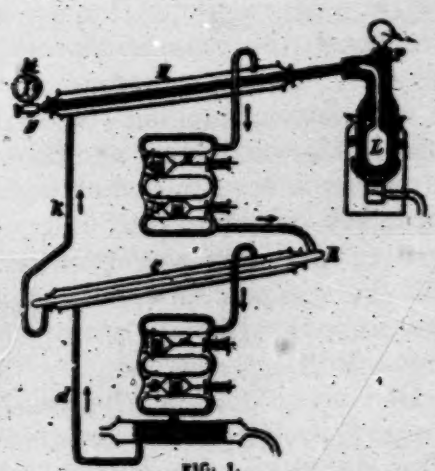


FIG. 7.

a tube or barrel. It had been prepared in the liquid state before the year 1800 A. D. Chlorine was condensed by

Northmore in 1805, but his experiments attracted little attention till years later, when Faraday had made a specialty of the liquefaction of gases; and the attention of the scientific world was drawn to the subject. Then, as usually happens, forgotten records were found of earlier work on the same lines. The later, but independent, observation by Faraday (1823) of the liquefaction of chlorine is, however, the commencement of the systematic study of the subject. Faraday has the only kind of priority which is of real importance in scientific discovery, that, namely, of being the first to make the subject fruitful, and the first to make its importance generally understood. Faraday had been experimenting on the solid hydrate of chlorine which separates out in yellowish crystals when ice cold water is saturated with chlorine gas. Sir Humphry Davy, to whom at that time Faraday acted as assistant, suggested that the crystals should be sealed up in a glass tube and heated. Davy gave at the time no reason for his suggestion, and Faraday himself did not know what to anticipate from the experiment. The crystals of the solid hydrate were placed at one end of a ∧-shaped glass tube, which was then closed by sealing up the glass in the blowpipe flame. The crystals being warmed to 60° F. underwent no change, but at 100° F. "the substance fused, the tube became filled with a bright yellow atmosphere, and on examination was found to contain two fluid substances; the one (chlorine water), about three-fourths of the whole, was of a faint yellowish color, having very much the appearance of water; the remaining fourth was a heavy bright yellow fluid, lying at the bottom of the former without any apparent tendency to mix with it." At 70° F. the pale portion congealed (i. e., the hydrate separated out), although even at 32° F the yellow portion did not solidify.

Heated up to 100° F. the yellow fluid appeared to boil and again produced the bright colored atmosphere. It was found that by heating to 100° F. the yellow liquid (fluid chlorine) could be distilled from the pale colored liquid (chlorine water) so as to get them in different limbs of the bent tube. "If, when the fluids were separated, the tube was cut in the middle, the parts flew asunder as if with an explosion, the whole of the yellow portion disappeared,

and there was a powerful atmosphere of chlorine produced; the pale portion, on the contrary, remained, and when examined proved to be a weak solution of chlorine in water with a little muriatic acid."

The paper from which the above extracts are taken was read before the Royal society by Sir Humphry Davy in 1823. In a note at the end of Faraday's paper, Davy says that "in desiring Mr. Faraday to expose the hydrate of chlorine to heat in a closed glass tube, it occurred to me that one of three things would happen—that it would become fluid as a hydrate, or that a decomposition of water would occur (forming hydrochloric acid), or that the chlorine would separate in a condensed state." Further on he remarks; "I cannot conclude this note without observing that the generation of elastic substances in close vessels, either with or without heat, offers much more powerful means of approximating molecules than those dependent upon the application of cold, whether natural or artificial, for as gases diminish only about 1/480 in volume for every degree of Fahrenheit's scale, beginning at ordinary temperatures, a very slight condensation only can be produced by the most powerful freezing mixtures, not half as much as would result from the application of a strong flame to one part of a glass tube, the other part being of ordinary temperature; and when attempts are made to condense gases into fluids by sudden mechanical compression, the heat instantly generated presents a formidable obstacle to the success of the experiment, whereas in the compression resulting from their slow generation in close vessels, if the process be conducted with common precautions, there is no source of difficulty or danger; and it may easily be assisted by artificial cold, in cases where gases approach near to that point of compression and temperature at which they become vapors."

This "bent tube" method was successfully employed by Faraday in the liquefaction of a number of other gases.

In 1822, the year preceding Faraday's experiments on chlorine, Caignier de la Tour had examined the effects pro- [fol. 407] duced by heating volatile liquids, such as alcohol or ether, in closed tubes. In these experiments the liquid put into the tube was heated, so that the conditions were

different from those of Faraday's experiments. De la Tour observed that up to a certain temperature the liquid continued slowly to evaporate, the bulk of liquid diminishing,

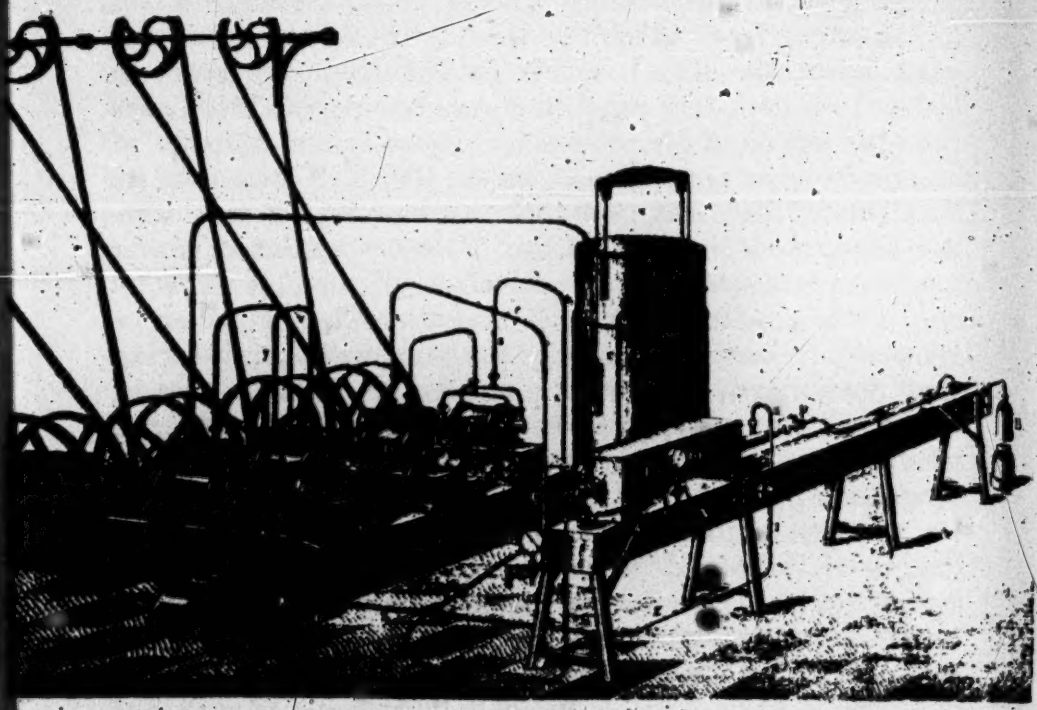


FIG. 2.

and the quantity of vapor increasing. This was the ordinary process of evaporation, which the eye can trace by observing that the position of the meniscus which separates the liquid and the vapor becomes lower and lower as the temperature increases.

When, however, a certain temperature is reached the meniscus suddenly disappears, and there no longer ap-

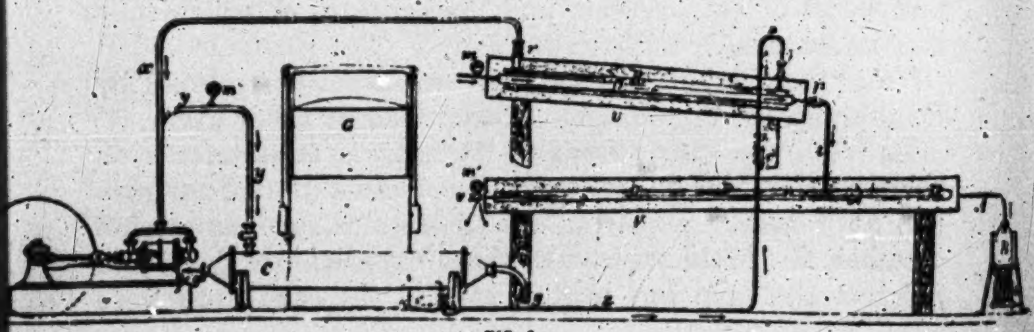


FIG. 3.

pears to be any liquid in the tube. On cooling the tube, the inverse change takes place with equal suddenness, a meniscus (the line of separation between liquid and vapor) suddenly appears, showing that on lowering the temperature a large amount of liquid is suddenly formed. De la Tour's experiments point to conclusions quite opposite to those of Davy, quoted above; since the "approximation of particles" brought about by pressure was more than counterbalanced by the repellant action of heat.

In 1845, in a second paper on liquefaction of gases, Faraday writes with a mastery of the subject which neither he nor Davy possessed in 1826. He says: "My hopes of success beyond that heretofore obtained depending more upon depression of temperature than on the pressure which I could employ in these tubes, I endeavored to obtain a still greater degree of cold. There are, in fact, some results no pressure may be able to effect. Thus, solidification has not yet been conferred on a fluid (i. e., a gas) by any degree of pressure. Again; that beautiful condition which Caignier de la Tour made known, and which comes on with liquids at a certain heat, may have its point of temperature for some of the bodies to be experimented with, as oxygen, hydrogen, nitrogen, etc., below that belonging to the bath of carbonic acid and ether, and in that case no pressure which any apparatus could bear would be able to bring them into the liquid or the solid state." The "bath of carbonic — and ether" here referred to was a device for obtaining a very low temperature, a kind of improved freezing mixture, in fact. Thilorier and afterward Natterer had constructed apparatus in which carbonic acid gas could be liquefied by pressure alone. When liquid carbonic acid is exposed to the air at the ordinary pressure, some of the liquid evaporates very rapidly, thereby chilling the lower layers of liquid to such an extent that they freeze, forming solid carbonic acid. If ether be mixed with this solid carbonic acid, and if the pressure be diminished by means of the air pump, the further cooling due to evaporation of the ether reduces the temperature to —110° C. This extremely low temperature was employed in experiments by which Faraday endeavored unsuccessfully to liquefy hydrogen, [fol. 408] oxygen and nitrogen. Andrews employed the same means of producing cold, but used more powerful ap-

paratus for compression. Although by combined cold and pressure the above named gases were reduced to less than 1/500 of their original volume, no liquefaction took place. Andrews also conducted experiments upon the phenomenon observed by De la Tour, and showed that above the "critical temperature" of 31° C. the greatest pressure which he could bring to bear was not sufficient to liquefy carbonic acid, but that, if the temperature were lowered, the liquefaction took place at once.

In the latter and successful experiments on the liquefaction of the "permanent gases," such as nitrogen, oxygen

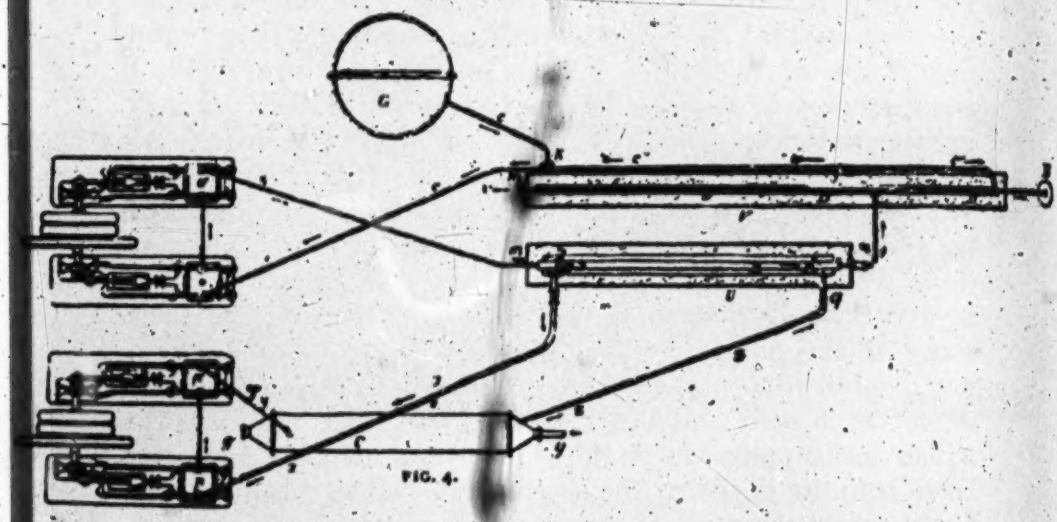


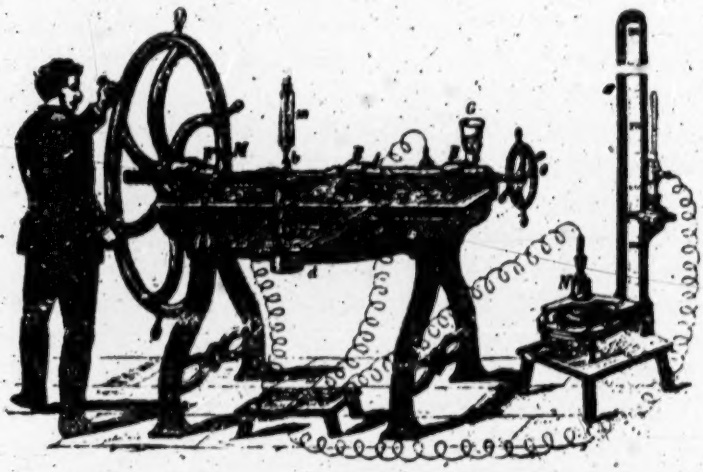
FIG. 4.

and hydrogen, the skill of the experimenter has been chiefly shown in the means devised for obtaining temperatures below the "critical point" of these gases. Pictet, of Geneva, who liquefied oxygen in 1877, relied for the production of a low temperature upon the well known principle of latent heat of evaporation. The novelty in his application of this principle lay in the fact that he employed two evaporating substances—namely, sulphur dioxide and carbonic acid. By the use of the doubly acting pumps employed in refrigerating machinery liquid sulphur dioxide can be obtained having a temperature of —65° C. In Pictet's apparatus the cold liquid sulphur dioxide is contained in an annular vessel, which forms a jacket round the tube in which carbonic acid is condensed by the action of another doubly acting pump.

The liquid carbonic acid is reduced to a temperature of 65° C. by the cooling action of the "jacket," and, consequently, when the pump is reversed and used as an exhaust pump, the evaporation of the cooled liquid produces an extremely low temperature, and the vapor can again be condensed so as to form a liquid jacket round the oxygen tube, having a temperature of –130° C. This tube of copper was was very strong to withstand pressure. The oxygen gas was passed into the tube direct from a strong iron retort in which it was evolved, and thus the pressure continued to rise as more and more oxygen entered the tube. At a pressure of about 500 atmospheres, the manometer remained stationary, showing that liquefaction has begun. The whole of the tube was at length filled with liquid oxygen, which was examined by opening a stopcock, when a jet of lustrous liquid issued with great force from the tube, to be speedily dissipated by evaporation.

The apparatus used by Pictet is shown in the accompanying illustration (Figs. 1 to 4). Fig. 1 illustrates the principle on which the apparatus works, and Figs. 2 to 4 show the practical arrangement of the different parts constituting the same. In Fig. 1 the letters represent as follows: A and B, two suction and pressure pumps connected for compound effect; C, receptacle for liquid sulphurous acid; d, back-flow for the liquefied sulphurous acid to C, E and F, suction and pressure pumps for carbonic acid. K, receptacle or tube for liquid carbonic acid. K carries the liquid carbonic acid to H, where surrounding the tube for oxygen, it speedily evaporates; N, valve of the oxygen tube; M, pressure gauge; L, very strong rod iron retort for the generation of oxygen; O, gas stove to heat this retort. Fig. 2 shows a general view of the apparatus in working order. Fig. 3, a sectional elevation, and Fig. 4 a sectional ground plan of the same. The letters represent the same parts in Figs. 2 to 4, viz.: G, receptacle for carbonic acid gas; O and O′, suction and pressure pump for carbonic acid; c, c′, pipes for carbonic acid. C, receptacle for sulphurous acid; p and p′, suction and pressure pump for sulphurous acid; g, g′, pipe for cooling water; y, x and z, pipes for sulphurous acid. S, tube for liquid carbonic acid; S, tube for liquid sulphurous acid; t, pipe to convey liquid carbonic acid to tube D, surrounding the oxygen tube A; m, valve at oxygen

tube. B, iron retort, and b, gas stove for the preparation of oxygen from chlorate of potash.



Cailletet, who worked independently at the same problem, first succeeded in liquefying oxygen on the very same day as Pictet. He employed simpler appliances, and worked on a different principle. He relied for obtaining his frigorific effect upon the chaleur de detente, or latent heat of expansion, of the gas with which he was working. The term "latent heat of expansion" is not a very good [fol. 409] one, as gas is not cooled by merely expanding to fill a vacuum. When, however, a gas is allowed to expand in such a way as to do mechanical work, the gas loses in heat the thermal equivalent of the mechanical work performed. In Cailletet's experiments, the gas was contained over mercury in the capillary bore of an immensely strong glass tube. The tube was screwed into a hydraulic press worked by the leverage of a large wheel. The experimental glass tube was surrounded by a freezing mixture of which the temperature for the experiments was not lower than about —30° C. So that in Cailletet's experiments no attempt was made to surround the gas with a very cold atmosphere. When the pressure attained 300 atmospheres the oxygen still remained in the gaseous condition, being much above the critical temperature; but, on suddenly withdrawing the constraining force from the piston of the press, the gas as suddenly expands, the elasticity or spring of the gas drives back the liquid and the piston, and the sudden

mechanical effect of the gas is accompanied by a sudden chill sufficient to bring the temperature below the critical point. The liquefied oxygen was seen in the tube immediately after the pressure was released.

The apparatus used by Cailletet is shown in Fig. 5, in which B represents the cylinder of the hydraulic press; F, screw, the turning of which moves the piston of the press; G, vessel filled with water for feeding the press; O, wheel of the screw valve which closes off G from B when the piston is forced into the cylinder. N N', pressure gauges; the spirals represent fine copper tubing; m a b represents the tube for the condensation of the gases, which is shown enlarged in Fig. 6, illustrating the details of its mounting and connections. Cailletet's method had the advantage that the process could be watched through the glass walls of the tube. On the other hand, Pictet's arrangement enabled him to prepare a larger quantity of the material, and to observe its behavior when exposed freely to the atmosphere. As we have said, the liquefied oxygen was dissipated immediately by evaporation, so that no examination of its properties could be made. A fine mist, or cloud, which formed when the oxygen evaporated may have been due to small particles of solid oxygen.

Experiments conducted since those of Cailletet and Pictet, fifteen years ago, have been designed so as to permit of the examination of the physical properties of the liquefied substances. This has been effected by obtaining such low temperatures of the material, and such a low temperature of its immediate surroundings, that the evaporation of the liquid (whether hydrogen, oxygen or nitrogen) only takes place slowly under ordinary atmospheric pressure. In Cailletet's experiments a liquid was obtained under low pressure, but the surroundings of the liquid were relatively warm, so that the substance could not long remain liquid. In Pictet's experiments the liquid could only be examined by removing it from the cold atmosphere. In the experiments conducted by Dr. K. Olszewski the gas to be experimented on was contained in the innermost of four glass tubes placed one within the other. In the outermost tube was placed solid carbonic acid and ether. By placing this in connection with an air pump, the temperature of the

neighboring tubes was reduced to —100° C. This was the method for obtaining low temperatures employed by Faraday in his later researches. Now comes a novelty. Ethylene gas, brought from a Natterer's cylinder, is led into the (second) inner tube. Here it is liquefied by low temperature, and under a considerable pressure. The two innermost tubes (into which the oxygen or hydrogen are presently to be brought) are now surrounded by a tube containing liquid ethylene at about —100° C. This liquid is protected from the warmth of the air by the outermost jacketing tube of carbonic acid ice. By the action of an air pump the pressure on the liquid ethylene is reduced to 10 mm. of mercury (about 1/76 the ordinary atmospheric pressure); dry air at the same time is cautiously blown through the ethylene to prevent its evaporation from becoming violent. The gas (say oxygen) is now passed into the two innermost tubes. The intense cold produced by the evaporation of the liquid ethylene, the liquid being to begin with at about —100° C., liquefies the oxygen, which is under a considerable pressure. But one more device remains to be mentioned, the most singular of all in Dr. Olszewski's process. The two innermost tubes, as has been said, contain the liquefied oxygen. They are now both put into connection with the air pump, and the pressure is cautiously diminished. The liquid in both tubes begins to evaporate, and is thereby chilled. Presently the liquid in the outer tube begins to evaporate more quickly than that in the innermost one, owing to the fact that it is in contact with the (relatively) warm ethylene tube. The whole of the liquid in the outer tube consequently evaporates, while there still remains a considerable portion of the liquid in the innermost tube. The temperature of the innermost tube has now sunk considerably lower than that of the liquid ethylene. Notrogen can be frozen in this way. By diminishing the pressure on the solid nitrogen, and thereby causing evaporation, Olszewski obtained a temperature of —225°.

The exceedingly cold liquid contained in the innermost tube is protected from the relatively warm ethylene by the non-conducting layer of rarefied gas in the intermediate tube. Consequently, the substance remains liquid at atmospheric pressure, or even at lower pressure, for a space of time (five to fifteen minutes) sufficient to allow of an

examination of some of the important physical properties. Thus the specific gravity is determined by measuring the height at which the liquid stands in the tube, hence deducing the volume of the liquid; then collecting the gas after evaporation, and measuring its volume. The weight of a given volume of gas is, of course, well known. This is necessarily equal to the weight of the liquid before evaporation. Hence we know the weight of the liquid in the tube. Its volume having been ascertained in the way described, the specific gravity is readily calculated under atmospheric pressure; it is found that

	Melts at	Bolts at	Critical Temp.
Oxygen		—164°	—118.8° C. Sp. gr. of liquid. 1.124 at —181.4° C.
Nitrogen	—214°	—194.4°	—146° C. Sp. gr. of liquid. 0.885 at —194° C.

Hydrogen at —213° C. liquefied under a pressure of 190 atmospheres; with Pictet's temperature of 140° C. a pressure of 650 atmospheres was required. The temperatures recorded in the above observations were all registered with a hydrogen thermometer. The critical point of hydrogen is —220° C.

[fol. 410] Ice and Refrigeration

apartment with the upper part of said ice apartment; a downward air flue communicating from the lower part of said ice apartment to the lower part of said produce apartment, and a chemical refrigerator located in said downward air flue, adapted to intensify the cold air as it falls from said ice storage apartment to the produce apartment substantially as set forth.

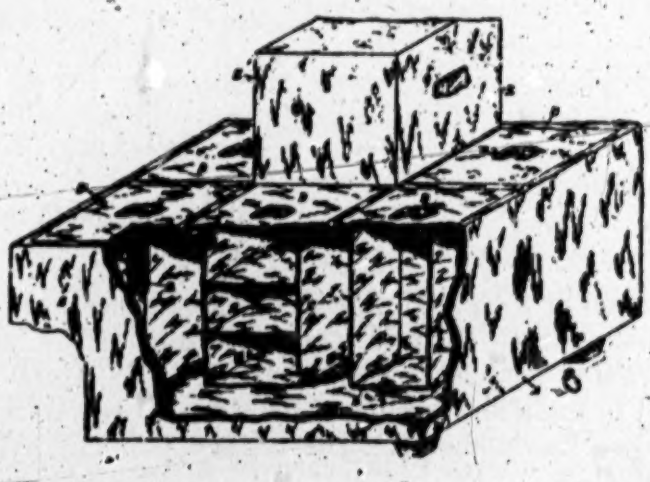
3. In a refrigerator or cold storage building the combination with the ice apartment and produce apartment located below said ice apartment, having upward and downward air flues communicating between said apartments of a series of metallic ice receivers suspended at their upper end from the floor of said ice apartment and extending down-

ward to said produce apartment, all substantially as and for the purpose specified.

Refrigerator

No. 490,055. William M. Wood, Boston, Mass. Filed April 8, 1892. Serial No. 428,266. Patented January 17, 1893. (No model.)

Claim.—The herein described refrigerator, consisting of the case A of non-conducting material, provided with a top

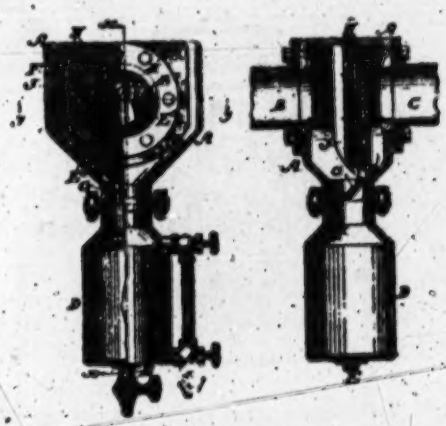


having openings into which separately removable boxes B, B, C are fitted, and the removable chamber E for containing a refrigerant arranged above and communicating with the interior of the refrigerator, substantially as described.

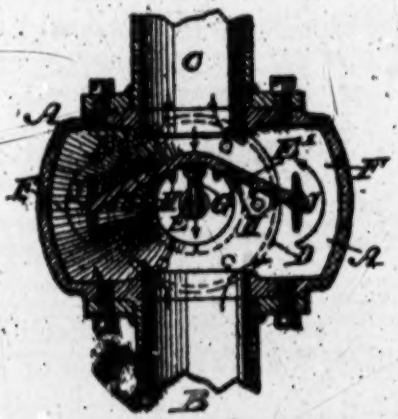
Separator for Steam

No. 483,992. David Cochrane, Philadelphia, Pa., assignor to Harrison Safety Boiler Works, same place. Filed July 30, 1892. Serial No. 441,670. Patented October 11, 1892. (No model.)

Claim.—1. A separator consisting of a casing with inlet and outlet pipes, a communicating well below the same, and a baffle plate, which latter extends vertically in said casing and forms a chamber which is closed at top and bottom and has passages at its sides, substantially as described.



2. A separator having in the casing thereof a vertically extending baffle plate forming a chamber which is closed at top and bottom, and has passages at its sides and reflected toward the outlet side, substantially as described.



3. A separator having a baffle plate in the casing thereof, which forms a chamber, the same being closed at top and bottom, and has passages at its sides, a communicating well below said casing, and a drain pipe at the base of the baffle plate, leading from the discharge side of the casing to said well, said parts being combined substantially as described.

Water Cooler

No. 488,473. William H. Fruen, Minneapolis, Minn. Filed May 22, 1891. Serial No. 393,702. Patented December 20, 1892. (No model.)

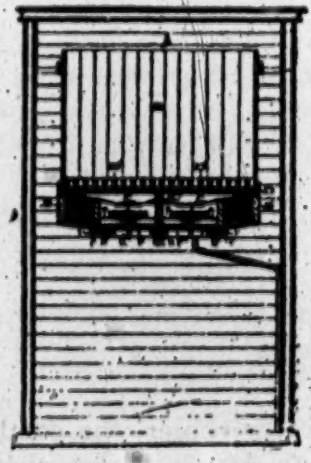
Claim.—1. In a water cooler, the combination of a base A' having a cross-bar A^2 projecting above and connecting

its opposite upper edges, an outer casing B, connected by its lower edge to the upper outer edge of said base, a disk D connected to said base and forming a bottom thereto below the line of said outer casing or shell, an inner shell H′ resting upon said cross-bar within said outer shell, an annular ring E uniting the upper edge of said inner and outer shell, and non-conducting filling a between said shells and disk D, substantially as and for the purpose set forth, whereby the weight of said inner shell is borne by said cross-bar.

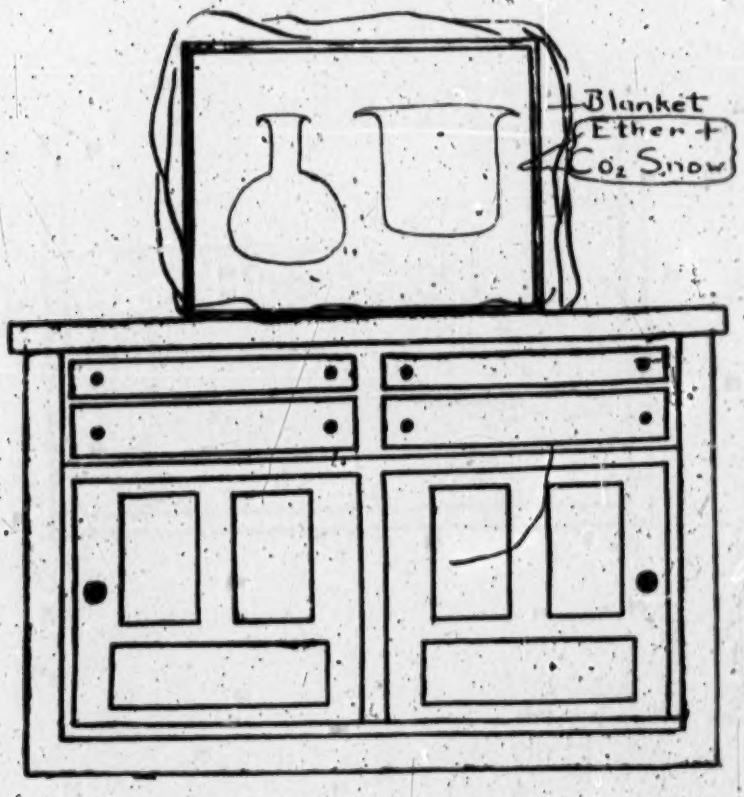
Refrigerator

No. 489,004. Louis Heller, Omaha, Neb. Filed September 23, 1891. Serial No. 406,613. Patented January 3, 1893. (No model.)

Claim.—1. In a refrigerator, the combination of a suspended ice chamber, the lower portion of said chamber be-



DEFENDANT'S EXHIBIT D 1 411



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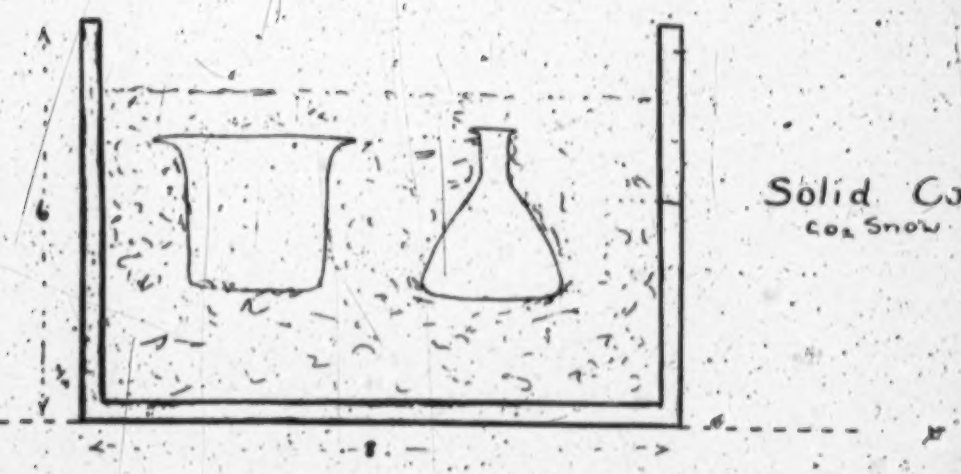

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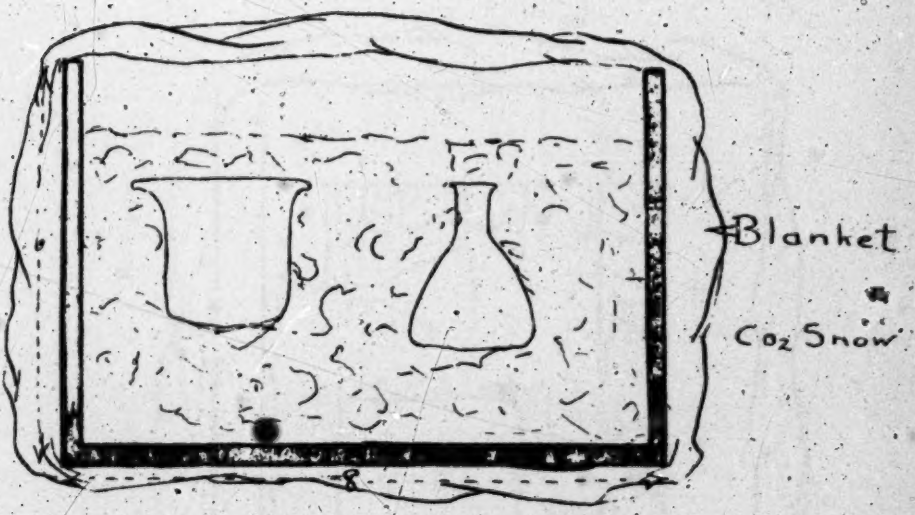

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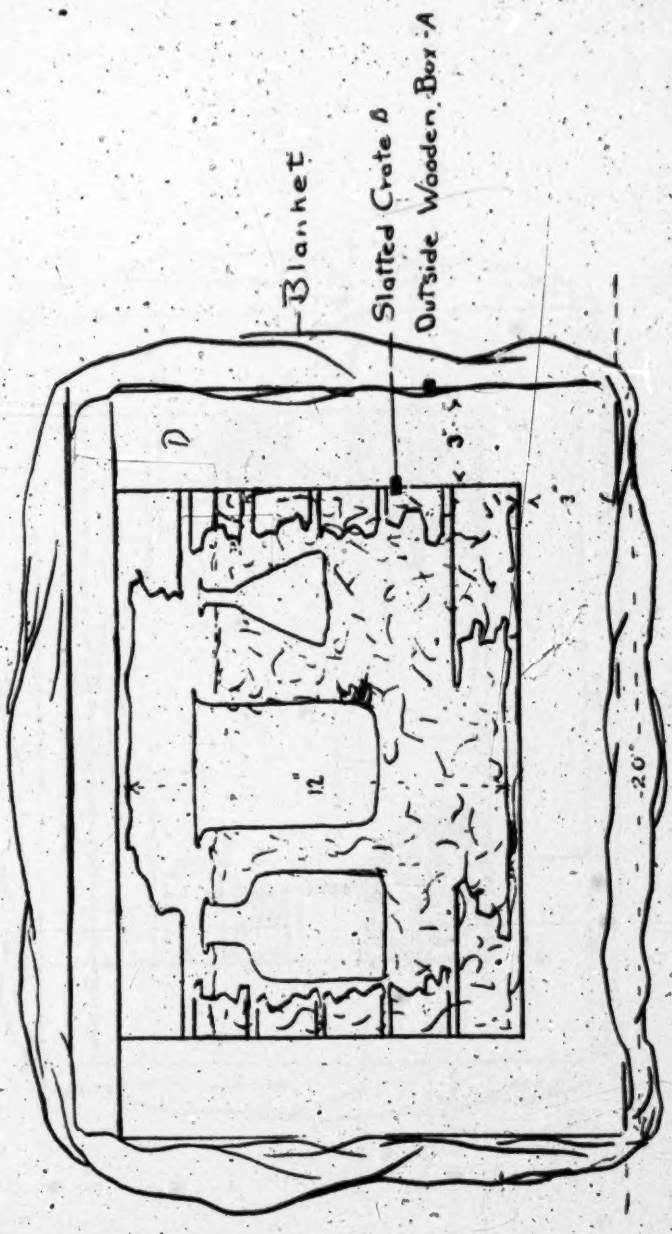

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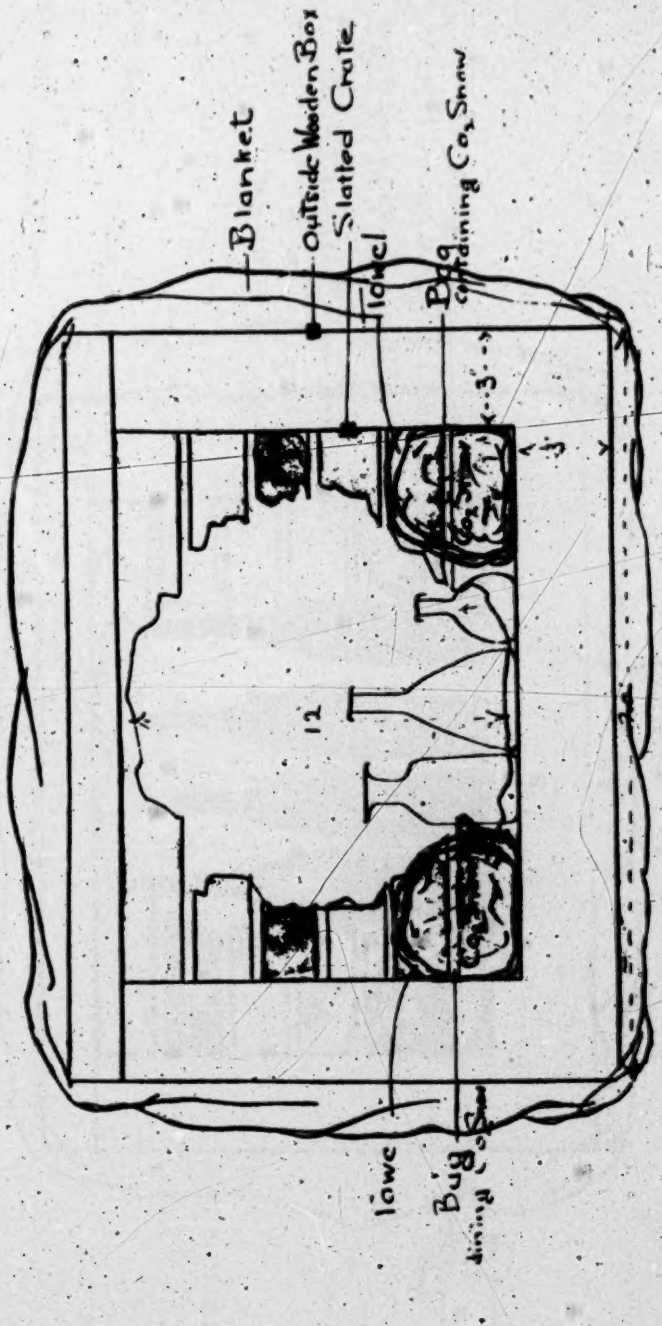

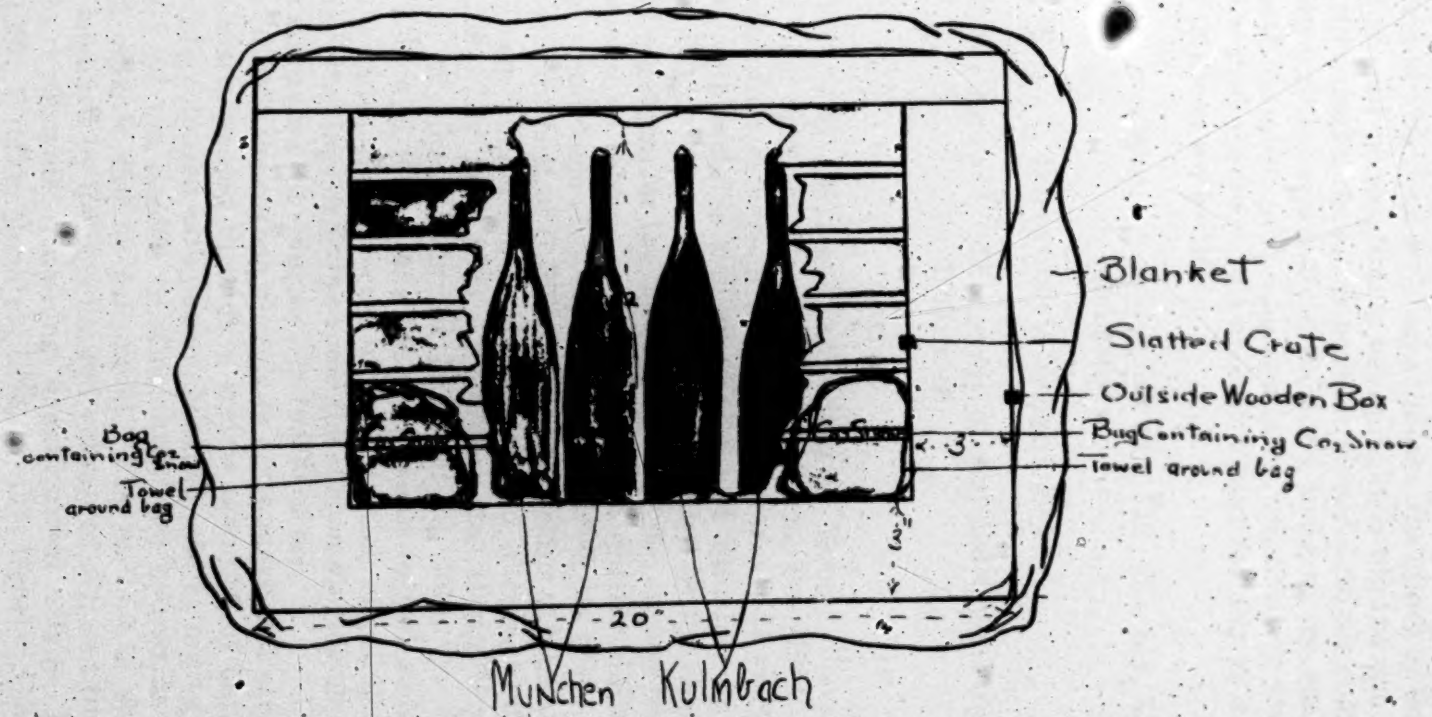
Blanket
Slatted Crate
Outside Wooden Box
Bag Containing Co_2 Snow
Towel around bag
Bag containing Co_2 Snow
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3
3"
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MUNchen
Kulmbach

ing provided with dead air compartments, the upper or deck portion of said compartments being inclined toward one or more drip troughs, the lower portion of said dead air chamber being inclined upwardly toward the walls, an ice guard above said chambers, and a horizontally reciprocating shutter below said chambers, all arranged substantially as and for the purpose set forth.

(Here follow drawings, side folios 411, 412, 413, 414, 415, and 416)

[fol. 417] DEFENDANT'S EXHIBIT E 1

Thorpe, Sir Edward, "Dictionary of Applied Chemistry." 1921, v. 2.

Carbon

rend. 1893, 116, 386); and, according to Moore, liberates nitrous acid from nitrites (J. Amer. Chem. Soc. 1904, 26, 959). Solution of carbon dioxide in water yields sodium formate with metallic sodium (Kolbe and Schmidt, Annalen, 119, 251). Carbon dioxide is assimilated by the chlorophyll of plants under the influence of sunlight, carbon being abstracted and oxygen set free. Carbon dioxide diffuses through caoutchouc (Kobbe, Chem. Zeit. 1890, 14. 1142).

The specific heat of carbon dioxide is greater at high than at ordinary temperatures (Berthelot and Vieille, Compt. rend. 98, 770 and 852). According to Hoppe-Seyler (Zeitsch. physikal. Chem. 10, 201, and 10, 401), the carbonic acid and marsh gas found in water-logged soils is due to a widespread process of fermentation of cellulose.

In any working- or living-room the carbon dioxide should not be more than 10 volumes per 10,000 of air.

To estimate the carbon dioxide in air, a measured sample of the air is passed through a known quantity of barium hydroxide, coloured with phenolphthalein, and by noting the quantity of air needed to decolourise the hydroxide the carbon dioxide can be calculated. The method is sometimes modified by using a limited volume of air, and titrating the hydroxide remaining unneutralised (Ballo, Ber. 1884, 1097; Wiener, Monatsh. 1894, 15, 429; Henriet, Compt. rend. 1896, 123, 125; Woodman, J. Amer. Chem. Soc. 1903,

25, 150; Jean, Compt. rend. 1902, 135, 746; J. Pharm. Chim. 1903, 27, 418; Pécoul and Levy, J. Soc. Chem. Ind. 1906, 655; Davies and McLellan, ibid. 1909, 232).

Carbon dioxide is used extensively in the arts for the manufacture of aërated waters, in sugar manufacture for separating lime from the juice of the sugar-cane, in bread making, and for raising and clarifying beer.

It is also employed for protecting wines from moulds and acetifying organisms. It preserves their aroma and bouquet, and makes the wine fresher, sweeter, and stronger. Wines can also be revivified by the gas (Piaz, J. Soc. Chem. Ind. 1894, 266; 1903, 644; Pini, Bull. de l'Assoc. des Chim. 1898, 15, 741). It also possesses antiseptic properties and retards the putrefaction of meat (Kolbe, J. pr. Chem. [2] 28, 61). It has also been proposed to use it as a motive power where fuel is expensive (Herbert, Chem. Zentr. 1885, 543, 558, 572).

Mixed with acetylene (about 5-8 p.c.), it decreases the smokiness of the flame and prevents the clogging of the burners (J. Gas Lighting, 1898, 72, 916).

Liquid carbon dioxide (Büchner, Zeitsch. physikal Chem. 1906, 54, 665) can be obtained in large quantities by an apparatus described by Thilorier (Annalen, 30, 122). Natterer compressed carbon dioxide by a specially constructed air-pump (J. pr. Chem. 35, 169); v. also Gore, Phil. Trans. 1861, 63). It is prepared from bisulphates by the action of carbonates, the apparatus consisting essentially of a leaden vessel containing a solution of the bisulphate and having a stirring apparatus and gear fixed air-tight to it. By means of a tube and pump an equivalent quantity of calcium carbonate (obtained as a waste product in the manufacture of caustic soda) suspended in water in a second vessel is forced in and the stirrer set in motion. The liberated carbon dioxide is dried and passed into a gasometer from which it is afterwards condensed. An apparatus is also described which allows the evaporation and expansion of liquid carbon dioxide to take place round a tube containing a solution of calcium chloride. The latter is so cooled that it may be used for the manufacture of ice. The carbon dioxide thus used is passed over moist sodium carbonate, converting it into bicarbonate, which may be again used in the carbonic acid manufactory

(Thomas, Zeitsch. angew. Chem. 1900, 386). (For description and figure of apparatus for liquifying CO_2 and for bottles in which it is stored and sold, see Sisson, J. Soc. Chem. Ind. 1904, 242.)

Liquid carbon dioxide may be bought in iron or steel bottles containing 8 kilos. (about 4000 litres of the gas at ordinary temperature and pressure), costing about 1 sh. per kilo. It furnishes the cheapest means for aërating waters, and is used for raising sunken ships, for driving torpedoes, for extinguishing fires, for cooling purposes, and, as 'Pictet's fluid,' for freezing machines, and by the firm of Krupp, in Essen, for the condensation of steel and other metals; and is further suggested as a motive power for tramcars and balloons (J. Soc. Chem. Ind. 4, 610).

It is also used for making carbonates and other chemical products, for filtering and sterilising organic liquids (d'Arsonval, Compt. rend. 1891, 112, 667), and in Germany for the generation of pressure on storage casks of beer to the faucets above where the beer is drawn for consumption. In Engineering, Dec. 3, 1903, a description is given of its use in railway signalling in outlying stations, to supply the motive power for working the signals, so as to avoid the expense of compression machinery or of long lengths of connecting pipes.

Liquid carbon dioxide is colourless, very soluble in alcohol, ether, and volatile oils, but does not mix with water. When the pressure is suddenly relieved, part of the carbon dioxide immediately vaporises, producing sufficient cold to solidify the remainder. Landolt allows the liquid to evaporate freely into woollen bags, and compresses the solid carbon dioxide in conical wooden moulds by wooden pistons (Ber. 17, 309); cf. Purcell (J. Soc. Chem. Ind. 1892, 936; Eng. Pat. 13684, 1891). A vessel for storing solid carbon dioxide is described by Heyl and Wultze (J. Soc. Chem. Ind. 1904, 1215; French Pat. 344957, 1904).

An apparatus for obtaining small and large quantities of solid carbon dioxide is described by Fechlu (J. pr. Chem. 1903, 67, 423; J. Soc. Chem. Ind. 1903, 626); also by Elsworthy (J. Soc. Chem. Ind. 1905, 1231). (For an apparatus for collecting solid carbon dioxide, v. Ducretet, Compt. rend. 99, 235.)

Solid carbon dioxide is a white, flocculent, snow-like mass, melting at —56.7° at 5 atmospheres pressure, and may be left exposed to the air for some time without sensible evaporation. An air or spirit thermometer immersed in it sinks to —79°; it can, however, be placed on the hand without any acute sensation of cold. By mixing with ether its refrigerating power is greatly increased. This is denied by Villard and Jerry (l.c.) but the temperature sinks to

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[fol. 418] DEFENDANT'S EXHIBIT E 2

Pellew, C. E. "Laboratory Text Book of General Chemistry", 1901

Carbon with Hydrogen and Oxygen

This liquid does not redden blue litmus paper nor possess any striking chemical properties.

It can readily be obtained in a solid form, like snow, by allowing some of the liquid carbon dioxide to escape from the exit valve of a cylinder into a cloth bag, the cold, produced by the sudden expansion of part of the liquid, condensing the rest into a solid form. Solid carbon dioxide melts at —65°, a point above its normal boiling point. If mixed with ether and allowed to evaporate under an air pump, the temperature will be reduced to —110°.

Chemically, carbon dioxide is a very stable compound, decomposing into carbon monoxide and oxygen only at a very high temperature, or, in minute quantities, under the influence of the electric spark. It will not, as a rule, support combustion, but a piece of magnesium tape or wire, once ignited, will continue to burn in it, forming magnesium oxide, and leaving a black deposit of carbon. It will also attack heated metallic sodium or potassium, forming alkaline carbonates, and liberating carbon.

It dissolves readily in water, at ordinary temperatures, one volume of water absorbing one volume of the gas, the proportion by weight increasing in accordance with the pressure.

This solution must be considered as, to some extent at least, a chemical combination, for in such a solution there

is always contained in a diluted form a certain quantity of a dibasic acid, carbonic acid, H_2CO_3. This is shown by the fact that wet carbon dioxide, or an aqueous solution of the same, reddens blue litmus paper, a property not shared by the dry gas. This acid is decomposed readily by heat or even by evaporation, into carbon dioxide and water. Hence the litmus paper, reddened by carbonic acid, again becomes blue on drying.

This acid, having two replaceable hydrogen atoms in its molecule, is able to form two different sets of salts, namely, the carbonates, and the acid or bi-carbonates. In the former, both hydrogen atoms are replaced by metals, and in the latter only one hydrogen atom is replaced. The bi-carbonates can be

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[fol. 419] DEFENDANT'S EXHIBIT E 3

The Journal of the Society of Chemical Industry

rise in temperature, can also be confirmed. If molecular quantities of citronellone and sodium acid sulphite are triturated in a mortar the latter will dissolve in the former, and upon the addition of a few drops of water the emulsion-like liquid will congeal. This method of preparing the addition product is not connected with the loss caused by the use of a solution of the sodium acid sulphite. An attempt to add two molecules of sodium acid sulphite failed.—G. H. R.

The Alkaloids of Certain of the Solanaceæ. O. Hesse.

Annalen, 1892, 271, 100—126

The author finds that atropine prepared from the pure commercial sulphate (Pharm. Germ. III.) melts at 115.5°, and has a specific rotatory power $[a]_D = -0.4$ ($p = 3.22$; $t = 15°$); whereas Will and Ladenburg believe it to be optically inactive, and Bredig gives its rotatory power as $[a]_D = -1.89$. Atropine sulphate—

$$(C_{17}H_{23}NO_3)_2H_2SO_4 + H_2O$$

is employed for opthalmic purposes. Of three samples of this salt, which stood the tests of the German Pharmaco-

pœia, two were found to contain hyoscyamine sulphate. Pure atropine sulphate separates on adding ether to its alcoholic solution in lustrous white needles; whilst when it is contaminated with hyoscyamine sulphate dull white crystalline aggregates are precipitated. The anhydrous salt has a specific rotatory power in 2 per cent. aqueous solution at 15° $[a]_D = -8.8$. The platinochloride melts at 197°—200°, and the aurochloride at 138°.

Hyoscyamine, $C_{17}H_{23}NO_3$, prepared from the seeds of Hyoscyamus niger and also from the commercial sulphate forms white needles, melting at 108.5°; its specific rotatory power in 3 per cent. absolute alcoholic solution at 15° was *was* found to be $[a]_D = -20.3°$. Will gives — 21.68 (Ber. 21, 1722). The sulphate crystallises with 2 mols. H_2O, melts at 201°, and the anhydrous salt has a specific rotatory power in 2 per cent. aqueous solution $[a]_D = -28.6$. The platinochloride melts at 206°, and the aurochloride at 159°.

A crystalline alkaloid comes into commerce under the name of atropinum naturale; it is prepared from belladonna roots, and most of the samples of commercial atropine sulphate are derived from this alkaloid. The base forms white needles, melts at 109°, and has a specific rotatory power in 2 per cent. absolute alcoholic solution at 15° $[a]_D = -16.2$. An optical analysis of the sulphate, employing the above given constants, showed it to be a mixture of hyoscyamine sulphate 68.2 per cent. and atropine sulphate 31.8 per cent.

Hyoscine was first isolated by Ladenburg from hyoscyamus niger (Annalen 206, 299). The author finds that it has the composition represented by the formula $C_{17}H_{21}NO_4$, and its specific rotatory power in 2 per cent. absolute alcoholic solution at 15° is $[a]_D = -13.7$. When hyoscine is heated with hydrochloric acid or an alkali, oscine, $C_8H_{13}NO_2$, melting at 104.5° and boiling at 242°, and atropic acid, $C_{18}H_{18}O_5$ are obtained.

The alkaloid obtained by E. Schmidt from Scopolia atropoides, and named by him scopolamine (Apotheker Zeit. 1890, 30) is identical with hyoscine. The author is in favour of retaining the name hyoscine (compare E. Schmidt, Archiv. d. Pharm. 230, 207).

The remainder of the paper deals with atropamine from belladonna roots (Annalen, 261, 87); belladonnine (Ber. 22,

3183); and apo-atropine, which closely resembles atropamine in its physical characteristics, and those of its derivatives, but is crystalline, whereas atropamine is amorphous. Apo-atropine is obtained by the action of nitric acid on atropine (Pesci, Ber. 15, 530; Ladenburg, Annalen, 117, 102).—A. R. L.

Cincholine and Fluoroline. O. Hesse. Annalen, 1892, 271, 95—100

Cincholine, $C_{10}H_{21}N_4$, is a volatile base met with in the preparation of cinchona alkaloids (Ber. 15, 858); it is identical with the base isolated by Weller from paraffin oil (Ber. 20, 2097), and is a highly refractive oil, boiling at 236°—238°. It is homologous with conine, but appears not to be poisonous. Fluoroline, $C_{12}H_{13}N$, is an oily volatile base obtained by the author in 1887 by the steam distillation of the so-called amorphous alkaloid of Trujillo coca; its solution in water exhibits a strong blue fluorescence. The author has failed to isolate the base from either Trujillo coca or Java coca, using purified solvents as extracting agents, so that its production from Trujillo coca (Giscl, Pharm. Zeit., 36, 420) was probably due to its presence in the solvent used, viz., brown coal naptha.—A. R. L.

Oxygen in Glass Manufacture. Eng. and Mining J. 54, 413

See under VIII., page 908

Patents

An Improved Process and Apparatus for the Manufacture of Solid Carbonic Acid (CO_2). C. R. C. Tichborne, A. E. Darley, S. Geoghegan, and M. F. Purcell, Dublin. Eng. Pat. 13,684, August 13, 1891.

Carbonic acid from brewers' vats (this Journal, 1891, 651), or from any suitable source, is liquefied in a series of stage compressors, the liquid cooled down in a surface condenser and admitted in regulated quantities into an expansion chamber. Part of the liquid volatilises here, and in consequence abstracts sufficient heat to cause the remaining

part of the liquefied carbonic acid to solidify. The gaseous carbonic acid may be returned to the pumps. The solidifying chamber may be made fixed or moveable; it is provided with a discharging door for the solid carbonic acid, and is coated with non-conducting material. Boxes, bags, or the solidifying chamber itself may be used for transporting the solid carbonic acid.—H. A.

Improvements in the Preparation of Anhydrous Oxide of Barium, or other Substances of Like Properties, for Use in the Separation of Oxygen and Nitrogen of Atmospheric Air. Brins Oxygen Company, Limited, and K. S. Murray, London. Eng. Pat. 17,298, October 10, 1891.

Pieces of fire-clay, pumice stone, or other inert material are saturated with fused barium nitrate at a high temperature, which is maintained for some time to drive off volatile impurities. The pieces are allowed to cool in an air-tight chamber. The barium oxide so produced presents a large surface for subsequent action on air.—H. A.

XXI.—Photographic Materials and Processes

Patents

Improvements in Apparatus for Washing Photographic Prints and Negatives. H. Holcroft, Wolverhampton. Eng. Pat. 19,706, November 13, 1891.

The improved apparatus consists in a cistern in which is fitted a carrier, provided with narrow ledges or corrugations to receive horizontal trays, upon which the negatives or prints to be washed are placed, the carrier is made somewhat shorter than the cistern in order to leave a water space at each end. The trays consist in frames on which a netting is strung. To prevent prints being washed out of the trays, vertical bars are fixed across the outflow end of the carrier, the ends of the trays being notched to correspond. Water is allowed to drip into one end of the cistern, flows over the surface of the prints or negatives, and escapes by an overflow.—J. C. C.

[fol. 420] DEFENDANT'S EXHIBIT E 4

Journal of the Society of Chemical Industry, 1904, volume 23

Journal and Patent Literature—Cl: VII

value, and that the term "flowers of sulphur" should be reserved for the product which shows not less than 33 per cent. of the insoluble variety at the time of production, and that the value of commercial samples be based upon this standard. Thus a sample containing 30 per cent. of insoluble sulphur should be described for trade purpose as containing 90 per cent. of "flowers of sulphur." The term "sublimed sulphur" should be applied to the whole product of sublimation without regard to its physical condition. —J. O. B.

Potassium Ferrocyanide; Influence of Anode on Electrolytic Oxidation of ——. A. Brochet and J. Petit. XI. A., page 1222.

Iron Cyanogen Compounds; Blue ——. K. A. Hofmann, O. Heine, and F. Höchtlen. IV., page 1209.

Phosphates; Colorimetric Determination of ——. O. Schreiner and B. E. Brown. XXIII., page 1240.

English Patents

Oxygen; Preparation of ——. G. F. Jaubert, Paris. Eng. Pat. 26,148, Nov. 30, 1903. Under Internat. Conv., July 3, 1903.

See Addition, of July 3, 1903, to Fr. Pat. 325,627 of 1902; this J., 1903, 1348.—T. F. B.

Nitrogen and Oxygen from Atmospheric Air; Apparatus for the Separation of ——. R. P. Pietet, Steglitz, Germany. Eng. Pat. 14,431, June 27, 1904. Under Internat. Conv. June 27, 1903.

See Addition, of June 27, 1903, to Fr. Pat. 322,600 of 1902; this J., 1904, 371.—T. F. B.

United States Patents

Barium Hydrate; Manufacture of ——. F. Jahn, Assignor to Harrison Bros. and Co. U. S. Pat. 775,752, Nov. 22, 1904. XI. A., page 1223.

Bisulphite Liquor; Apparatus for Preparing ——. P. Drewsen and J. Parent, Assignors to Drewsen-Parent Construction Co., Shawano, Wis. U. S. Pat. 774,869, Nov. 15, 1904.

An elongated closed tank with a substantially flat bottom has its liquid supply at one end, and gas supply and discharge port at the opposite end. There are agitators, each consisting of a shaft provided with blades in and across the tank, and each having a dam in the tank's bottom behind it. There are also removable pipe sections having return bends suspended in the tank, from a bar resting on its edges, and adapted to carry "temperature controlling water" through them.—E. S.

French Patents

Hydrochloric Acid and Sulphuric Acid; Process for the Production and Simultaneous Separation of ——. Consortium für Elektrochem. Ind. Second Addition, dated June 27, 1904, to Fr. Pat. 335,496 of Aug. 24, 1903. (See this J., 1904, 252 and 606.)

For "acide sulfurique aqueux" in the second sentence of the second paragraph of the specification of the main patent, read "acide muriatique aqueux."—E. S.

Products having great Affinity for Water [Sulphuric Anhydride, &c.]; Process for the Condensation of ——. A. H. Perret. Fr. Pat. 344,964, July 19, 1904.

The products, such as sulphuric and phosphoric anhydrides, are distilled in a retort communicating with receivers, not sealed, but surrounded by materials not readily conducting heat and into which receptacles air, cooled and dried, is passed as it issues from a chamber in which a

strong solution of calcium chloride, for instance, is continuously showered down.—E. S.

Arsenious Acid; Apparatus for the Extraction of —— from Ores. E. Biguet. Fr. Pat. 345,063, July 23, 1904.

The apparatus includes a series of muffles, in which the arsenical ore is so heated as to sublime the arsenic, which passes into a chamber to which air is admitted, arsenious anhydride being formed and deposited. Air is aspirated through the entire apparatus in such manner as to lead the vapours through a series of large condensor chambers, and then through complementary chambers of special construction. Lastly, the vapours are led up a coke tower, sprayed at the top with water. The sulphurous acid thus collected, is treated with limestone.—E. S.

Carbonic Acid; Obtaining —— from Solutions of Bicarbonate. Chem. Techn. Fabr. Dr. A. R. Brand and Co. Fr. Pat. 344,744, July 9, 1904.

The alkali bicarbonate solution, mixed, if necessary, with soap or grease, to make a lather, is fed continuously through a tubular apparatus, heated by gases from a furnace passing through a central horizontal pipe. The froth produced passes to a cooler, where it is cooled by the incoming liquid; the froth subsides, the liberated carbon dioxide being collected and the residual solution of monocarbonate used for absorbing carbon dioxide from gases of combustion.—E. S.

Carbonic Acid; Process for the Storage and Transport of —— in a Solid State and at a Low Temperature. Gebr. Heyl and Co., and A. Wultze. Fr. Pat. 344,957, July 19, 1904.

As the carbon dioxide is stored in the solid state, the recipients need not be of great resisting power. The recipient shown in Fig. 1 is provided with a double envelop enclosing an empty space b, for reception of a refrigerating mixture, such as a mixture of carbon dioxide and ether;

Fig. 1.

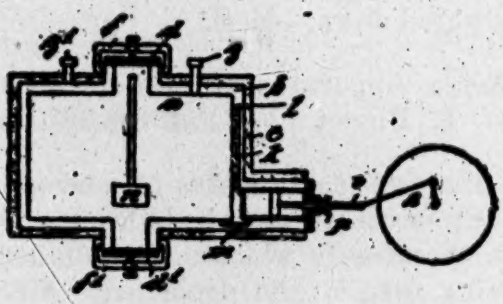

Fig. 2.

the outer layer c is of some non-heat-conducting material. The continual evaporation of the cooling liquid maintains the carbon dioxide within the receptacle in the solid state. g and g' are safety valves. A small apparatus for aspiration and compression is set within the space b, the piston to which is actuated from e outside the apparatus, as shown. The vapours arising from the volatile mixture are aspirated at l, through the tube k, and are compressed and liquefied by means of the tuyères m in the evaporating chamber, the process continuing as long as the motive force is applied. A force-pump, o, n, serves to remove the solid dioxide, which may be conveyed into the steel cylinder shown in Fig. 2, fitted with double envelope, &c. like that represented in Fig. 1. Such cylinders are provided with means for charging and discharging similar to those in ordinary use for storing and conveying liquid carbon dioxide.—E. S.

Ammonia; Manufacture of ——. H. C. Woltereck.

Fr. Pat. 345,399, Aug. 6, 1904.

A mixture of air and steam is caused to act upon peat heated in a retort at a temperature not higher than 550° C., and,

[fol. 421] DEFENDANT'S EXHIBIT E 5

Roscoe & Schorlemmer. "Treatise on Chemistry"
Ed. 5, v. 1, 1920

The Non-metallic Elements

After the dioxide had liquefied it was distilled over into the receiving cylinder.

Natterer,[1] of Vienna, and Bianchi, of Paris, later on constructed an apparatus in which carbon dioxide prepared in a separate vessel was compressed by means of powerful pumps into wrought-iron pear-shaped vessels, and this principle is still adopted, except that the wrought-iron vessels have now been replaced by cylinders of mild steel, which

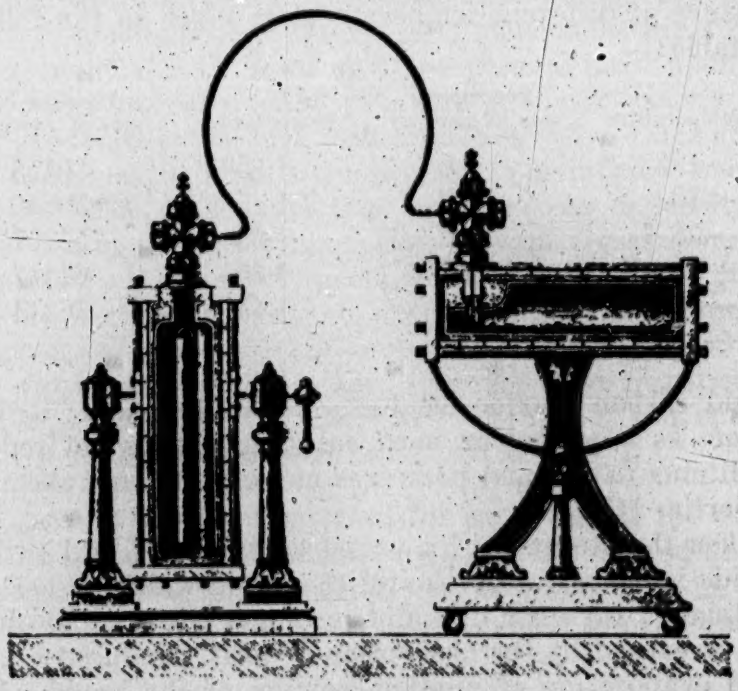

FIG. 189.

contain about 8 litres. These are chiefly filled in certain large breweries from the carbon dioxide given off during fermentation, and also from the gas evolved from certain

[1] J. pr. Chem. 1845, 35, 169.

springs such as those at Burghold on the Rhine, or from gas specially prepared in other ways (p. 805).

It is now largely sold and used for producing cold, as well as high pressures, and is therefore employed in the manufacture of cast steel. It is also employed for beer-engines, in the manufacture of salicylic acid, and for the production of aërated waters.

Liquid carbon dioxide is a colourless, very mobile liquid, [fol. 422] slightly soluble in water, upon the surface of which it floats. Its specific gravity is 0.9951 at —10°, 0.9470 at 0°, and 0.8266 at +20°.[1] These numbers show that liquid carbon dioxide expands more upon heating than a gas, and its coefficient of expansion is larger than that of any known substance. The boiling point of liquid carbon dioxide is —80° under a pressure of 760 mm., and its vapour pressure at different temperatures is given in the following table:—

Temperature	Pressure in mm. of mercury	Temperature	Pressure in mm. of mercury
—125°	5	+ 5°	30753
—80°	760	+15	39646
—56·7	3876	+25	50207
—25	13007	+35	62447
—15	17582	+45	76314
— 5	23441		

Liquid carbon dioxide conducts electricity badly; it does not act as a solvent on most substances, does not redden dry litmus paper, and possesses no very striking chemical properties (Gore).

When the stopcock of a vessel containing liquid carbon dioxide is opened, a portion of the liquid which rushes out solidifies in the form of white snow-like flakes (Thilorier). This is caused by the absorption of heat, produced by the rapid evaporation of another portion of the liquid. For the purpose of obtaining larger quantities of this carbon dioxide snow, the apparatus shown in Figs. 190 and 191, suggested by Natterer, is employed. It consists of two brass cylinders, AB and CD, one of which can be fixed inside

[1] Andreef, Annalen, 1859, 119, 1.

the other, each being fastened to a hollow non-conducting handle. The liquid carbon dioxide is allowed to pass quickly from the nozzle of the cylinder containing the liquid through the tube d (the position of which inside the box is shown in Fig. 191). A portion of the liquid undergoes evaporation and passes out as gas through the fine holes in the handles, whilst the larger portion remains behind as a solid, finely divided, crystalline, bulky mass, capable of being pressed together like snow. It can also be readily prepared by blowing liquid dioxide into a bag of coarse canvas, which retains the solid, whilst allowing the liberated gas to pass away. Solid carbon dioxide, both in the compressed and snow-like form, evaporates very slowly in the air, because of the large amount of heat volatilisa-
[fol. 423] tion required. Notwithstanding its excessively low temperature it may be touched without danger, the gas which it constantly emits forming a non-conducting atmosphere round it. If, however, it be pressed hard upon the skin, solid carbon dioxide produces a blister exactly like that produced by contact with a red-hot body. This snow-like mass may be readily compressed in cylindrical wooden moulds. The solid mass thus obtained has a density of about 1.2, and requires a considerable time for evaporation in the air.[1] When solid carbon dioxide is mixed with ether, and the mixture brought into a vacuum of an air-pump, the temperature sinks to —110°. A tube containing liquid carbon dioxide brought into this solidifies to a transparent, ice-like solid mass (Mitchell and Faraday), the specific gravity of the ice-like solid being 1.56 at —79°.

A process has been patented for carrying out the manufacture of solid carbonic acid by a similar method on the large scale. The solid material may be transported in bags or casks, or in the iron chamber in which it is produced.

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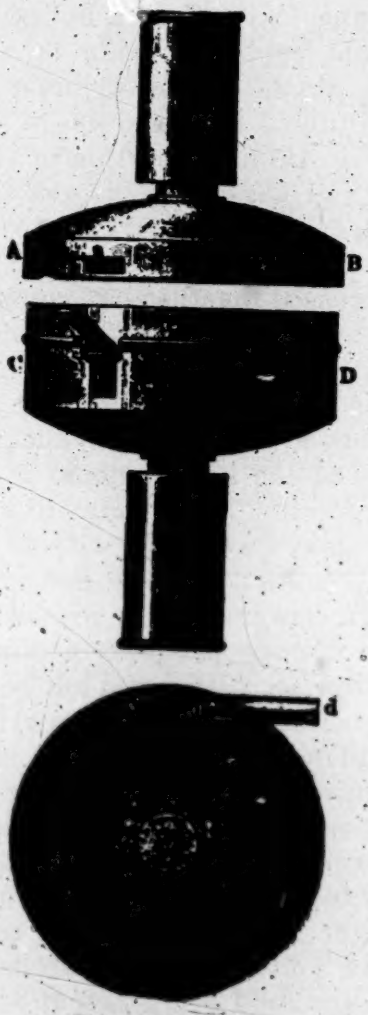
[1] Landolt, Ber. 1884, 17, 309.

English Patent 13,684 (1891).



FIGS. 190 and 191.

Formula of Carbon Dioxide.—It has already been shown (p. 776) that carbon dioxide is formed by the combination of 12 parts of carbon with 32 parts of oxygen. Further, when carbon burns in oxygen to form the dioxide, the volume of the latter produced is equal to that of the oxygen used, and hence one molecule of the gas must contain two atoms of oxygen, this being in agreement with the formula CO_2, in which the atomic weight of carbon is taken as 12.

[fol. 424] DEFENDANT'S EXHIBIT E 6

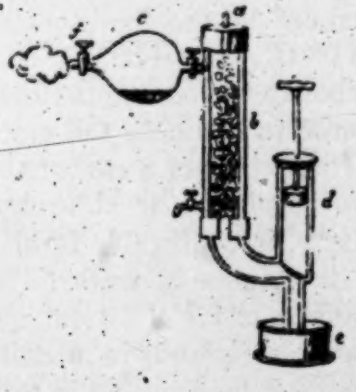
Thomson, Dictionary of Chemistry, New Edition

Car.

Obtained in this way, carbonic acid is a colourless liquid, very fluid and light, with a refracting power inferior to water. At 32° its elasticity is equal to 36 atmospheres, specific gravity 0-838.

Solid Carbonic Acid.—Thilorier has succeeded (Ann. Chim. 60, 427) by imitating in the first instance the experiment of Faraday—using iron cylinders instead of glass—in condensing carbonic acid into a liquid, and then by an ingenious method of causing it to revolve when emitted by the stop-cock round a hollow hemisphere, it vapourizes and produces so much cold as to cause it to condense into a solid form like snow.

A more safe and convenient method is to prepare the fluid acid by means of a pump. A strong cylinder of iron b,



lined with lead, is filled with pieces of marble through an aperture a at the top. A force pump d draws dilute chlorohydric acid from e in contact with the marble. A stop-cock allows the evolved carbonic acid to pass into the strong iron receiver c, where it condenses into the fluid state. On opening the stop-cock, the fluid passes in the form of vapour. When received in Thilorier's receiver it is solid.

The temperature of this solid cannot be less than —148°. The effect of touching this cold mass with the tongue is re-

markable. A sensation of burning is produced, and a blister results; when mixed with a small portion of ether and mercury, the metal may be frozen in considerable quantity. The elasticity of the vapour of carbonic acid as determined by Mr. Addams is as follows:—

Temperat.	Lbs. per square inch	Atmospheres of 15 lbs. each
0	280	18.1
10	300	20
30	398	26.5
32	413	27.6
50	520	34.7
100	935	62.3
150	1496	99.7

Liquid carbonic acid is capable of mixing in all proportions with oil of turpentine, bisulphide of carbon, alcohol, ether, naphtha; water and fatty oils are, however, incapable of dissolving it. When in union with alcohol, the compound may be frozen; it melts at —135, probably the lowest temperature ever measured by the thermometer. Spec. grav. at —20° C. is .90 at 0° C. .83 at +30° C. .60.

Analyses of Carbonates.—In a quantitative analysis of carbonates, it is usual to estimate the amount of carbonic acid by the loss sustained when a carbonate is acted on by a stronger acid, as sulphuric or chlorohydric acids; the former, from its fixity, is preferable in all cases when the resulting sulphate is soluble in water. Introduce into a light flask about 150 grs. of oil of vitriol, and dilute it with an equal bulk of water; weigh out in a small tube 50 grs. of the carbonate; suspend it by a thread in the flask, and close

the mouth of the flask by a perforated cork and tube filled with chloride of calcium. Then weigh accurately the whole

apparatus; allow the tube to descend into the acid, cork tightly, and gradually by agitation allow the acid to act upon the carbonate in the tube. On the cessation of effervescence, heat the flask gently; release the cork slightly, apply a suction tube to the top of the chloride of calcium tube, and suck out the carbonic acid; lastly, weigh the apparatus. The loss indicates the amount of carbonic acid in 50 grs. of the carbonate.

Carbonic Oxide

	Vd.		Spec. grav.	Atoms	Wts.	
Carbon	1	□	.4234	1	.75	43.38
Oxygen	½	□	.55281	1	1.	56.62
			.97621		1.75	100.

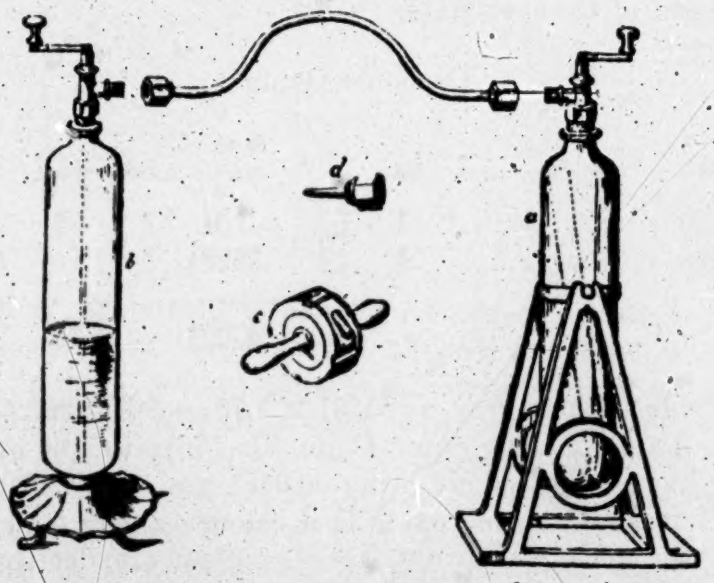
Calculated spec. grav. = 55281 × 1.75 = .9674; refractive power 1.157 (Dulong, Ann. Chim. 31, 166); weight of 100 cubic inches, that of air being 30.9451 grs. = 30.2089 grs. Characters.—Carbonic oxide is a colourless gas, and possesses the mechanical properties of common air; destitute of taste and smell. It possesses neither acid nor alkaline action on vegetable colours, and is a neutral body. It has not been condensed into a liquid; 100 vols. water absorb 2 of this gas (Davy, Thomson), 3.7 (Dalton), 6 (Saussure). Cold carbonic oxide when ignited gives a blue flame, but when previously heated a yellowish-red flame (Gmelin). In the formation of ball soda, the carbonic oxide evolved in the furnaces gives a yellow flame, due probably to the soda. Animals cannot exist in it, but when immersed in it are immediately asphyxiated. It is one of the most poisonous gases known (Leblanc) when existing in atmospheric air. All gases containing carbon have been found more or less to interfere with the natural physiological state when respired. When mixed with common air it does not explode like hydrogen, but burns brilliantly.

[fol. 425] DEFENDANT'S EXHIBIT E 7

Graham, Elements of Chemistry, Ed. 2, v. 1, 1850

Gases

FIG. 34



mouth of the generator, and firmly screwed down upon it, with the intervention of a leaden washer, the generator is turned round upon its supporting pivots, so as completely to invert it; the brass measure within is thus canted over, and the acid which it contained mixed with the solution of soda. The carbonic acid of the salt, which amounts to half its weight, is thus disengaged, and accumulates with great elastic force in the vacant part of the generator. The charge of gas is then transferred to the other large cylinder, which is used as a receiver, by attaching it to the generator by the connecting tube, and after the lapse of five minutes, opening the stopcocks of both. It is advisable to have a woollen case or bag about the receiver, to hold fragments of ice for cooling it. The cylinders may again be separated, after shutting the stopcocks, and the same operations repeated. After two or three charges of gas are conveyed into the receiver, the pressure of the latter becomes suffi-

cient to liquefy the gas; and after five or six charges the receiver may contain several pints of liquid carbonic acid. The receiver being finally detached is set aside, and the liquid it contains preserved for use.

When this highly volatile liquid is allowed to escape into air it evaporates so readily that one portion is instantly resolved into gas, and another portion is cooled so low by the heat thus abstracted as to freeze. From the stopcock [fol. 426] of the receiver b, a small tube, shewn in the figure, descends to near the bottom and dips into the liquid; so that upon opening the former it is the liquid, and not gaseous carbonic acid, which escapes. A nozzle, d, being applied to the receiver, the stream of liquid is directed into a small cylindrical box of thin copper, c, with hollow wooden handles, which is soon filled with solid carbonic acid, in the form of a white substance like snow, or more closely resembling anhydrous phosphoric acid, from its opacity and entire want of crystallization.

Solid carbonic acid is a very bad conductor of heat, and may, therefore, be handled without injury, although its temperature is supposed to be so low as —100° C., or —148° Fahr.; and also preserved in the air for hours, if a considerable mass of it in a glass vessel be placed within another similar and larger glass vessel, with any non-conducting material between them. When applied to produce cold, in order to give it contact the solid carbonic acid is mixed with a little ether, with which it unites and forms a soft semifluid mass like half melted snow, capable of abstracting heat and evaporating rapidly, by means of which mercury can be frozen in large quantities, and an alcohol thermometer sunk in the open air so low as —135° (Thilorier). The apparatus of Thilorier forms thus an invaluable cold-producing machine.

Mr. Faraday has since produced a still lower degree of cold by placing a bath of Thilorier's mixture of solid carbonic acid and ether in the receiver of an air-pump, from which the air and gaseous carbonic acid were rapidly removed. The bath consisted of an earthenware dish of the capacity of four cubic inches or more, which was fitted into a similar dish somewhat larger, with three or four folds of dry flannel intervening; with the mixture in the inner dish

such a bath lasted for twenty or thirty minutes, retaining solid carbonic acid the whole time. An alcohol thermometer placed in the bath, merely covered with paper, fell to —106°; and in the air-pump receiver, exhausted to within 1.2 inch mercury of a vacuum, the thermometer fell to —166°; or a cold of 60 degrees additional was produced by promoting the evaporation in this manner. At this low temperature the solid carbonic acid, mixed with ether, was not more volatile than water at the temperature of 86°, or alcohol at ordinary temperatures.

By combining this extreme cooling power with the effect of mechanical pressure upon gases, several most interesting results were obtained. To produce the pressure, Mr. Faraday employed two con- —

[fol. 427] DEFENDANT'S EXHIBIT E 8

Carbanhydride

Gas made on a large scale by action of sulphuric acid on mixture of chalk and water; in laboratories, by action of dilute hydrochloric acid on marble.

γ. Its frequent occurrence as a product of the decomposition of organic acids by heat, and of various decompositions of organic compounds in general.

Carbanhydride a colourless, inodorous, almost tasteless gas. Its extinction of combustion and of life. Accidents from evolution of carbanhydride in wells, caverns, fermenting vats, limekilns, &c. Its action, even when much diluted, as a narcotic. Specific gravity of gas, $\frac{12+16\times 2}{2}$ =22, or one and a half times that of air (1.524 Regnault). Its collection by downward displacement, and capability of being poured through air. Variation in its coefficients of compressibility, and of dilatability by heat, at low temperatures. Its liquefaction, by pressure of 38.5 atmospheres at 0°. Production of liquid carbanhydride on a large scale, from decomposition by sulphuric acid of hydro-sodium carbonate $HNaCO_3$, in Thilorier's or Nat-

terer's apparatus. Gas generated under pressure in (or afterwards compressed into) iron cylinders. A thin, colourless liquid of sp. gr. 0.83 at 0°, immiscible with water, miscible in all proportions with alcohol, ether, and essential oils. Its general resemblance to disulphide of carbon. Its great expansibility by heat. Solid carbanhydride usually produced as a snow-white flocculent mass, by spontaneous evaporation of stream of liquid anhydride escaping under pressure. Its low temperature, —77°, maintained by constant volatilisation. Its capability, nevertheless, of being handled, &c., owing to an absence of contact, by reason of its volatilisation. Its comparative permanence when surrounded by non-conducting materials. Employment of solid carbanhydride, wetted with ether, as a frigorific agent; readily capable of freezing mercury. Freezing or melting point of mercury —39°. Depression of temperature to —110°, by volatilisation of solid carbanhydride and ether under receiver of air-pump. Production of carbanhydride in form of ice, by cooling the liquid, in a bath of the solid anhydride and ether.

[fol. 428] DEFENDANT'S EXHIBIT E 9

Spons' Encyclopedia of the Industrial Arts, Manufactures and Commercial Products, v. 1., 1879

Carbonic Acid

When liquid carbon anhydride is suddenly freed from pressure, it is instantaneously converted into the gaseous form, and by the operation such intense cold is produced, that a portion of the liquid is frozen. It then forms the solid anhydride, a white, snow-like mass. Though this substance has so low a temperature as —78°, it can be handled without inconvenience, owing to a constant volatilization, which keeps it from actual contact with the hand. Wetted with ether, solid carbonic anhydride forms the most effectual freezing mixture known, a temperature of —110° being obtainable, and mercury instantly solidified into a lead-like mass. If when liquefying the gas at a temperature of —87° the pressure is increased to four atmospheres,

a solid mass is obtained, which has the transparency of ice, and may be divided into crystals, which have the action of intense heat when pressed between the fingers.

It remains only to notice the aqueous solution of carbon dioxide, the only real acid form of the compound. The gaseous anhydride dissolves in its own volume of water, giving a solution of 1.0018 sp. gr. with a sharp acid taste, and possessing decided acid properties. By boiling this aqueous solution, however, the gas is evolved, and litmus no longer reddened. It is owing to this that hard water can be softened by boiling, the carbonate of lime yielding up to its carbon dioxide, and being deposited in the kettle or boiler in the shape of "fur." If the gas be simply passed into water, only about two-thirds of the bulk of the solvents is taken up; but if the pressure is increased or the temperature diminished, the solubility is very much greater. Hence water impregnated with the gas at a high pressure immediately parts with it when the pressure is removed. For further details of this part of the subject see "Aerated Waters."

The following table gives the volumes of carbonic anhydride absorbed by 1 volume of water under a pressure of 760 mme., and at the temperatures indicated:—

Temp.	Vols. of gas absorbed	Temp.	Vols. of gas absorbed
0	1.7697	12	1.1018
2	1.6481	14	1.0321
4	1.5126	16	
6	1.3901	18	.93018
8	1.2809	20	0.9013
10	1.1847		

The column marked a in the annexed table shows the volume of gas absorbed at the ordinary temperature of the air, and under the pressures indicated by the column marked P.

P	a	P	a
697.71	0.9441	2188.65	3.1764
809.03	1.1619	2369.02	3.4857
1289.41	1.8647	2554.00	3.7152
1469.95	2.1623	2738.33	4.0031
2002.06	2.9076	3109.51	4.5006

Carbonic acid, the aqueous solution of the gas, forms a series of exceedingly valuable salts called "carbonates."

They are obtained by the direct action of the acid, or by the joint operation of the anhydride and water, upon metallic oxides or hydrates. In no case does the anhydride unite with a base without the intervention of water. Certain of the carbonates are also very readily produced by precipitating a soluble metallic salt with an alkaline carbonate. For the most part they are soluble in water and insoluble in alcohol; they are decomposed by the action of heat, and of water with the aid of heat.

The carbonates constitute an exceedingly important set of compounds, whether they be viewed from a geological, chemical, or purely industrial standpoint. The limestones form no inconsiderable portion of the earth's crust, and the value of these under their several forms of chalk, mountain limestone, and marble, is too well known to be insisted upon. The carbonates of potash, soda, ammonia, and lead, are prepared on a large scale for various purposes. Some of the most valuable metallic ores are carbonates. The most important of these salts are the carbonates of baryta, copper, iron, lead, lime, magnesia, potash, soda, and zinc.

All the carbonates, soluble and insoluble, are decomposed with effervescence by the strong acids. The gas which is given off is colourless, and of a somewhat pungent odour. If it be passed into milk of lime, or into a mixture of chloride of barium and caustic ammonia, a white precipitate is thrown down, though often not until the liquor has been heated. The same effects are produced

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[fol. 429] DEFENDANT'S EXHIBIT E 10

Newth, C. "Chemical Lecture Experiments" 1892

Chemical Lecture Experiments

To show the liquefaction of carbon dioxide by pressure. (See Liquefaction of Gases.)

407. To collect solid carbon dioxide. This is effected by causing a stream of the liquefied gas to issue from an iron bottle through a fine jet, into a metal box specially constructed for the purpose. Fig. 131 shows the usual form of

FIG. 131

the apparatus. The side tube receives the nozzle of the gas bottle, and the issuing stream of liquid is made to impinge upon the curved tongue of metal, and is thereby caused to revolve inside the box. The escaping gas issues by the perforated plates through the insulated wooden handles. As the solid collects in the box, small fragments are driven out through the handles, and the operator can tell by the quantity so escaping when the box is full. As the ordinary pressure guage is not available for ascertaining what quantity of carbon dioxide is contained in the cylinder, it is well to know the weight of the bottle when free of liquid, and also its weight when full. To avoid mistakes, these weights should be made with the nozzle and handle removed. The solid when collected should be removed from the metal receiver and placed in a cardboard box, which may be thickly covered with felt.

The substance should be handled with some care, a wooden spatula or paper knife being the best for cutting and lifting it. It may be placed upon the hand or even upon the tongue with impunity, but if lifted with the fingers care must be taken to avoid squeezing it, as, the pressure bringing it in contact with the skin, the intense cold will produce unpleasant blisters.

408. To show the evolution of carbon dioxide gas from the solid. A fragment of the solid may be placed in an empty soda-water bottle, which is then gently corked up; in a few moments the cork will be forcibly ejected.

[fol. 430] 409. A fragment may be placed in a small flask fitted with a cork and delivery tube, the latter dipping into lime-water. The lime-water will be at once rendered turbid.

410. A fragment placed in a cylinder, loosely covered with a glass plate, will rapidly displace all the air, and fill

the cylinder with the gas, which can be tested by a taper or by lime-water.

411. A fragment may be placed in a flask with delivery tube, and the gas collected at the pneumatic trough, when the regular and steady evolution of the gas will be seen.

412. A small fragment may be placed upon the tongue, and the evolving gas gently breathed upon a lighted candle or taper, which will be at once extinguished.

413. To freeze water with solid carbon dioxide. A small tin can with a wire handle is placed upon a wooden stand, upon which a small quantity of water has been poured; a few small pieces of the solid are thrown into the tin, and moistened with a little ether. The water will be almost instantly frozen, the solidification being accompanied by a crackling sound, and on lifting the can by its handle it will be seen that it is securely cemented to the stand.

414. To freeze mercury by means of solid carbon dioxide. About 80 cubic centimetres of mercury are placed in a

FIG. 132.

round-bottomed porcelain basin. In order that the mercury, when solidified, may be lifted from the dish, a stout copper-wire, bent into a flattened helix, is held in the mercury while it is being frozen; and, in order to prevent the frozen mercury from adhering to the dish itself, the latter is lined with paper, by pressing into it, with the fist, a piece of [fol. 431] writing paper, the edges of which may be trimmed with scissors. A quantity of solid carbon dioxide is placed upon the mercury, and the copper-wire is then introduced. A small quantity of ether is then poured upon the mercury, and in a few moments a solid crust begins to form, and the

wire will be held in its position by the frozen mercury. More solid carbon dioxide may be added until the mercury is entirely solidified throughout. The ether for these experiments should be fairly free from water and alcohol, and is conveniently used in a small wash-bottle.

415. The malleability of the solid mercury obtained above may be shown by lifting the lump from the dish and placing it upon a block of iron, which is wrapped in felt or thick flannel. It should be struck with a hammer, upon the head of which a piece of thick leather has been cemented. With such a hammer and anvil the mercury may be beaten into any shape, like a lump of lead, and little or none of it will be melted in the operation.

416. The solid mercury, after being hammered as above, may be plunged into water, by doing which the mercury will

FIG. 133.

be melted and the water frozen. This is strikingly shown by filling a tall, wide glass cylinder with water, and placing upon the top of the cylinder a piece of wire gauze, bent into the shape of a cap or dish. On placing the solid mercury into the water contained in this gauze dish, the metal melts, and running through the meshes, forms icicles several centimetres in length hanging from the gauze, and leaves a solid piece of ice in the cup adhering to the copper wire, by which it can be bodily withdrawn (fig. 133). It is well to use water which is only a few degrees above the freezing-point, and to throw a ray of strong light upon the vessel while the experiment is being performed.

417. The composition of carbon dioxide may be demonstrated by burning a small fragment of charcoal in a measured volume.

[fol. 432] DEFENDANT'S EXHIBIT E 11

Roscoe & Schorlemmer, Treatise on Chemistry, Ed. 3, v. 1, 1898

The Non-metallic Elements

the action of dilute sulphuric acid on bicarbonate of soda, is condensed by means of a force-pump into a wrought-iron pear-shaped vessel, seen in section in Fig. 194, furnished with suitable cocks, i, Fig. 194, the air which was contained in the flask being first of all displaced by the gas. During the operation the reservoir (r) is surrounded by a freezing mixture contained in a vessel, screwed on to the plate a b, Fig. 193.

415. Liquid carbon dioxide is now a commercial article and sold in iron bottles containing 8 kg., being mostly prepared in certain large breweries from the carbon dioxide evolved in the process of fermentation. It is also made from the natural gas evolved from certain springs, especially at Burgbrohl on the Rhine, and from the gas prepared from marble or sodium bicarbonate. The liquefaction is accomplished by compressing the gas by means of powerful pumps into recipients kept cool by a stream of water. It is used for producing cold, as well as high pressures, and therefore employed in the manufacture of cast steel. It is also employed for beer-engines, in the manufacture of salicylic acid, and for the production of aërated waters.

Liquid carbon dioxide is a colourless very mobile liquid slightly soluble in water, upon the surface of which it swims. Its specific gravity is 0·9951 at —10°, 0·9470 at 0°, and 0·8266 at +20°.[1] These numbers show that liquid carbon dioxide expands more upon heating than a gas, and its coefficient of expansion is, therefore, larger than that of any known body. The boiling-point of liquid carbon dioxide

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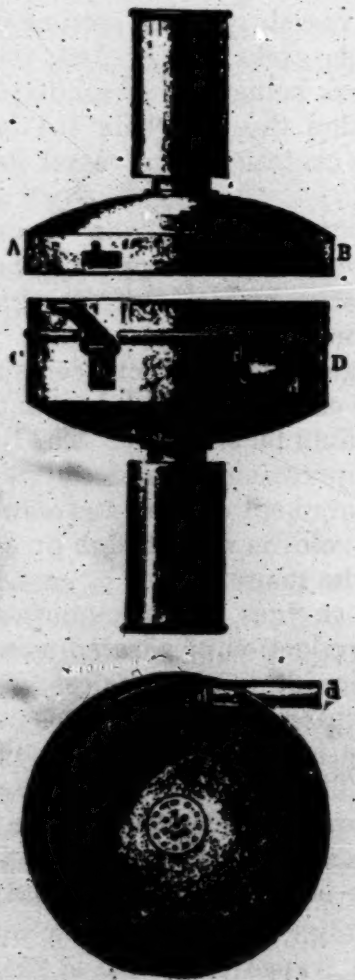
[1] Andreef, Annalen, 111.

is —78·2° under a pressure of 760 mm. and its tension at different temperatures is given in the following table:

Temperature	Pressure in mm. of mercury	Temperature	Pressure in mm. of mercury
— 25°	13007·02	+ 15°	39640·86
— 15	17582·48	+ 25	50207·32
— 5	23441·34	+ 35	62447·30
+ 5	30753·80	+ 45	76314·60

Liquid carbon dioxide conducts electricity badly; it does not act as a solvent on most substances, does not redden dry litmus paper, and possesses no very striking chemical properties (Gore).



FIGS. 195 and 196.

When the stopcock of a vessel containing liquor carbon dioxide is opened, a portion of the liquid which rushes out solidifies in the form of white snow-like flakes (Thilorier). This is caused by the absorption of heat, produced by the [fol. 433] rapid evaporation of another portion of the liquid. For the purpose of obtaining larger quantities of this carbon dioxide snow, the apparatus shown in Figs. 195 and 196, suggested by Natterer, is employed. It consists of two brass cylinders, AB and CD, one of which can be fixed inside the other, each cylinder being fastened to a hollow handle. The liquid carbon dioxide is allowed to pass quickly through the tube d (the position of which inside the box is shown in Fig. 196), from the nozzle n, Fig. 194, of the reservoir. A portion of the liquid undergoes evaporation and passes out as gas through the fine holes in the handles, whilst the larger portion remains behind as a solid finely divided crystalline mass, which is a very light substance, capable of being pressed together like snow. It evaporates much less quickly than the liquid dioxide, because it is much colder, and in addition it has to take up the amount of heat necessary for liquefaction. Notwithstanding its excessively low temperature it may be touched without danger, the gas which it constantly emits forming a non-conducting atmosphere round it. If, however, it be pressed hard upon the skin, solid carbon dioxide produces a blister exactly like that produced by contact with a red-hot body. This snow-like mass may readily be pressed into cylindrical wooden moulds. The cylinders thus obtained have a density of about 1·2, and require a considerable time for evaporation in the air.[1] When solid carbon dioxide is mixed with ether, [fol. 434] and the mixture brought into the vacuum of an air-pump, the temperature sinks to —110°. A tube containing liquid carbon dioxide brought into this solidifies to a transparent ice-like solid mass (Mitchell and Faraday). When liquid ammonia is placed over sulphuric acid in a vacuum and allowed to evaporate, such a diminution of temperature is obtained that gaseous carbonic acid may be liquefied. Exposed to a pressure of from 3 to 4 atmospheres, this solidifies, and the transparent mass thus obtained, when pressed with a glass rod, separates into cubical

[1] Landolt, Ber. 17, 309.

masses.[1] It is very remarkable that solid carbon dioxide melts at —65°, that is at a temperature lying much above its boiling point at the atmospheric pressure.

A process has been patented for carrying out the manufacture of solid carbonic acid by a similar method on the large scale. The solid material may be transported in bags or casks, or in the iron chamber in which it is produced.[2]

In the paragraph (24) concerning the continuity of the gaseous and liquid states of matter, it has been pointed out that a certain temperature may be reached for any given gas, above which this gas cannot be liquefied, however much the pressure may be increased. This temperature is termed by Andrews[3] the critical point, that of carbon dioxide being found by him to be 30·92°, whilst according to more recent observations it is 31·35°, the pressure at this temperature, or the critical pressure being 72·9 atmospheres.[4] In order to determine this point, Andrews employed the apparatus shown in Figs. 197 and 198. The dry and pure gas is contained in the glass tube a b, which is closed at a and open at b, the gas being shut in by the thread of mercury c. This tube is firmly bedded in the brass end-piece d, and this, in its turn, is bolted on to the strong copper tube which carries a second end-piece at its lower extremity. Through this the steel screw e passes packed with leather washers to render the cylinder perfectly airtight. The cylinder is completely filled with water, and the pressure on the gas is increased up to 400 atmospheres by turning the steel screw e into the water. The closed and capillary end of the tube containing the compressed gas is sometimes surrounded with a cylinder into which water of a given temperature is brought. A second modification of the apparatus is shown in Fig. 198. The capillary pressure-tube is bent round so as to render it possible to place it in a freezing

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(Here follow photostats of side folios 435 and 436)

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[1] Loir and Drion, Compt. Rend. 52, 748.
[2] English Patent 13,684, 1891.
[3] Phil Trans. 1869, part ii, 575.
[4] Amagat, Compt. Rend. 114, 1093.

DEFENDANT'S EXHIBIT E 12
Journal of the Society of Chemical Industry, 1904, volume 23.

value, and that the term "flowers of sulphur" should be reserved for the product which shows not less than 33 per cent. of the insoluble variety at the time of production, and that the value of commercial samples be based upon this standard. Thus a sample containing 30 per cent. of insoluble sulphur should be described for trade purposes as containing 90 per cent. of "flowers of sulphur." The term "sublimed sulphur" should be applied to the whole product of sublimation without regard to its physical condition.
—J. O. B.

Potassium Ferrocyanide; Influence of Anode on Electrolytic Oxidation of ——. A. Brochet and J. Petit. XI. A., page 1222.

Iron Cyanogen Compounds; Blue ——. K. A. Hofmann, O. Heine, and T. Hüchtlen. IV., page 1209.

Phosphates; Colorimetric Determination of ——. O. Schreiner and B. E. Brown. XXIII., page 1240.

ENGLISH PATENTS.

Oxygen; Preparation of ——. G. F. Jaubert, Paris. Eng. Pat. 26,148, Nov. 30, 1901. Under Internat. Conv., July 3, 1903.

See Addition, of July 3, 1903, to Fr. Pat. 325,627 of 1902; this J., 1903, 1348.—T. F. B.

Nitrogen and Oxygen from Atmospheric Air; Apparatus for the Separation of ——. R. P. Pictet, Steglitz, Germany. Eng. Pat. 14,431, June 27, 1904. Under Internat. Conv., June 27, 1903.

See Addition, of June 27, 1903, to Fr. Pat. 322,600 of 1902; this J., 1904, 271.—T. F. B.

UNITED STATES PATENTS.

Barium Hydrate; Manufacture of ——. F. John, Assignor to Harrison Bros. and Co. U.S. Pat. 775,732, Nov. 22, 1904. XI. A., page 1223.

Bisulphite Liquor; Apparatus for Preparing ——. P. Drewsen and J. Parent, Assignors to Drewsen-Parent Construction Co., Shawano, Wis. U.S. Pat. 774,869, Nov. 15, 1904.

An elongated closed tank with a substantially flat bottom has its liquid supply at one end, and gas supply and discharge port at the opposite end. There are agitators, each consisting of a shaft provided with blades in and across the tank, and each having a dam in the tank's bottom behind it. There are also removable pipe sections having return bends suspended in the tank, from a bar resting on its edges, and adapted to carry "temperature controlling water" through them.—E. S.

FRENCH PATENTS.

Hydrochloric Acid and Sulphuric Acid; Process for the Production and Simultaneous Separation of ——. Consortium für Elektrochem. Ind. Second Addition, dated June 27, 1904, to Fr. Pat. 335,496 of Aug. 24, 1903. (See this J., 1904, 252 and 606.)

For "acide sulfurique aqueux" in the second sentence of the second paragraph of the specification of the main patent, read "acide muriatique aqueux."—E. S.

Products having great Affinity for Water [Sulphuric Anhydride, &c.]; Process for the Condensation of ——. A. H. Perret. Fr. Pat. 344,964, July 19, 1904.

The products, such as sulphuric and phosphoric anhydrides, are distilled in a retort communicating with receivers, not sealed, but surrounded by materials not readily conducting heat and into which receptacles air, cooled and dried, is passed as it issues from a chamber in which a strong solution of calcium chloride, for instance, is continuously showered down.—E. S.

Arsenious Acid; Apparatus for the Extraction of —— *from Ores.* E. Bigaut. Fr. Pat. 343,063, July 23, 1904.

The apparatus includes a series of muffles, in which the ores are roasted, and a condenser, into which the vapours pass. The condenser consists of a chamber, in which the vapours are cooled by contact with the walls, and a series of chambers, in which they are cooled by contact with water. The arsenious anhydride is deposited in the first chamber, and the water in the other chambers takes up the sulphurous acid and sulphuric acid vapours.—E. S.

Carbonic Acid; Obtaining —— *from Solutions of Bicarbonate.* Chem. Techn. Fabr. Dr. A. R. Brand and Co. Fr. Pat. 344,744, July 9, 1904.

The alkali bicarbonate solution, mixed, if necessary, with soap or grease, to make a lather, is fed continuously through a tubular apparatus, heated by gases from a furnace passing through a central horizontal pipe. The froth produced passes to a cooler, where it is cooled by the incoming liquid; the froth subsides, the liberated carbon dioxide being collected and the residual solution of monocarbonate used for absorbing carbon dioxide from gases of combustion.
—E. S.

Carbonic Acid; Process for the Storage and Transport of —— *in a Solid State and at a Low Temperature.* Gebr. Heyl and Co., and A. Waltze. Fr. Pat. 344,957, July 19, 1904.

As the carbon dioxide is stored in the solid state, the recipients need not be of great resisting power. The recipient shown in Fig. 1 is provided with a double envelop-

FIG. 1.

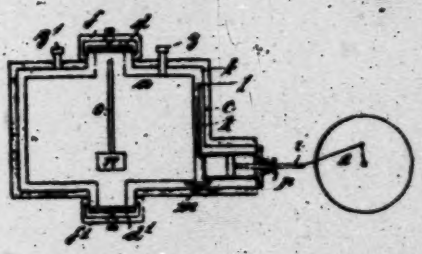

FIG. 2.

ing an empty space *b*, for reception of a refrigerating mixture, such as a mixture of carbon dioxide and ether; the outer layer *c* is of some non-heat-conducting material. The continual evaporation of the cooling liquid maintains the carbon dioxide within the receptacle in the solid state. *g* and *g*¹ are safety valves. A small apparatus for aspiration and compression is set within the space *b*, the piston to which is actuated from *e* outside the apparatus, as shown. The vapours arising from the volatile mixture are aspirated at *l*, through the tube *k*, and are compressed and liquefied by means of the tuyères *n* in the evaporating chamber, the process continuing as long as the motive force is applied. A force-pump, *o*, *n*, serves to remove the solid dioxide, which may be conveyed into the steel cylinder shown in Fig. 2, fitted with double envelope, &c. like that represented in Fig. 1. Such cylinders are provided with means for charging and discharging similar to those in ordinary use for storing and conveying liquid carbon dioxide.—E. S.

Ammonia; Manufacture of ——. H. C. Wolbetsek. Fr. Pat. 345,399, Aug. 6, 1904.

A MIXTURE of air and steam is caused to act upon peat heated [illegible] temperature not higher than 350° C., and

DEFENDANT'S EXHIBIT E 13 v. 11

436

rise in temperature, can also be confirmed. If molecular quantities of citronellone and sodium acid sulphite are triturated in a mortar the latter will dissolve in the former, and upon the addition of a few drops of water the emulsion-like liquid will congeal. This method of preparing the addition product is not connected with the loss caused by the use of a solution of the sodium acid sulphite. An attempt to add two molecules of sodium acid sulphite failed. —G. H. R.

The Alkaloids of Certain of the Solanaceæ. O. Hesse, Annalen, 1892, **271**, 100—126.

The author finds that atropine prepared from the pure commercial sulphate (Pharm. Germ. III.) melts at 115·5°, and has a specific rotatory power $[\alpha]_D = -0·4$ ($p = 3·22$; $t = 15°$); whereas Will and Ladenburg believe it to be optically inactive, and Bredig gives its rotatory power as $[\alpha]_D = -1·89$. Atropine sulphate—

$$(C_{17}H_{23}NO_3)_2H_2SO_4 + H_2O$$

is employed for opthalmic purposes. Of three samples of this salt, which stood the tests of the German Pharmacopœia, two were found to contain hyoscyamine sulphate. Pure atropine sulphate separates on adding ether to its alcoholic solution in lustrous white needles; whilst when it is contaminated with hyoscyamine sulphate dull white crystalline aggregates are precipitated. The anhydrous salt has a specific rotatory power in 2 per cent. aqueous solution at 15° $[\alpha]_D = -8·8$. The platinochloride melts at 197°—200°, and the aurochloride at 138°.

Hyoscyamine, $C_{17}H_{23}NO_3$, prepared from the seeds of *Hyoscyamus niger* and also from the commercial sulphate forms white needles, melting at 108·5°; its specific rotatory power in 2 per cent. absolute alcoholic solution at 15° was was found to be $[\alpha]_D = -20·2°$. Will gives $-21·68$ (Ber. **21**, 1722). The sulphate crystallises with 2 mols. H_2O, melts at 201°, and the anhydrous salt has a specific rotatory power in 2 per cent. aqueous solution $[\alpha]_D = -28·6$. The platinochloride melts at 206°, and the aurochloride at 159°.

A crystalline alkaloid comes into commerce under the name of *atropinum naturale*; it is prepared from belladonna roots, and most of the samples of commercial atropine sulphate are derived from this alkaloid. The base forms white needles, melts at 109°, and has a specific rotatory power in 2 per cent. absolute alcoholic solution at 15° $[\alpha]_D = -16·2$. An optical analysis of the sulphate, employing the above given constants, showed it to be a mixture of hyoscyamine sulphate 68·2 per cent. and atropine sulphate 31·8 per cent.

Hyoscine was first isolated by Ladenburg from *Hyoscyamus niger* (Annalen, **206**, 299). The author finds that it has the composition represented by the formula $C_{17}H_{21}NO_4$, and its specific rotatory power in 2 per cent. absolute alcoholic solution at 15° is $[\alpha]_D = +13·7$. When hyoscine is heated with hydrochloric acid or an alkali, *oscine*, $C_8H_{13}NO_2$, melting at 104·5° and boiling at 242°, and atropic acid, $C_9H_8O_2$, are obtained.

The alkaloid obtained by E. Schmidt from *Scopolia atropoides*, and named by him scopolamine (Apotheker Zeit. 1890, 30) is identical with hyoscine. The author is in favour of retaining the name hyoscine (compare E. Schmidt, Archiv. d. Pharm. **230**, 207).

The remainder of the paper deals with atropamine from belladonna roots (Annalen, **261**, 87); belladonnine (Ber. **22**, 3183); and apo atropine, which closely resembles atropamine in its physical characteristics, and those of its derivatives, but is crystalline, whereas atropamine is amorphous. Apo atropine is obtained by the action of nitric acid on atropine (Pesci, Ber. **15**, 530; Ladenburg, Annalen, **117**, 102).—A. R. L.

Cincholine and Fluoroline. O. Hesse. Annalen, 1892, **271**, 95—100.

Cincholine, $C_{18}H_{21}N_2$, is a volatile base met with in the preparation of cinchona alkaloids (Ber. **15**, 859); it is identical with the base isolated by Weller from paraffin oil (Ber. **20**, 2087), and is a highly refractive oil, boiling at 235—238°. It is homologous with conine, but appears not to be poisonous. *Fluoroline*, $C_{11}H_{11}N$, is an oily volatile base obtained by the author in 1887 by the steam distillation of the so called amorphous alkaloid of Trujillo coca; its solution in water exhibits a strong blue fluorescence. The author has failed to isolate the base from either Trujillo coca or Java coca, using purified solvents as extracting agents, so that its production from Trujillo coca (Gisel, Pharm. Zeit., **36**, 420) was probably due to its presence in the solvent used, viz., brown coal naphtha.—A. R. L.

Oxygen in Glass Manufacture. Eng. and Mining J. **54**, 412.

See under VIII., *page* 908.

PATENTS.

An Improved Process and Apparatus for the Manufacture of Solid Carbonic Acid (CO_2). C. H. C. Tichborne, A. E. Darley, S. Geoghegan, and M. F. Purcell, Dublin. Eng. Pat. 13,684, August 13, 1891.

Carbonic acid from brewers' vats (this Journal, 1891, 631), or from any suitable source, is liquefied in a series of stage compressors, the liquid cooled down in a surface condenser and admitted in regulated quantities into an expansion chamber. Part of the liquid volatilises here, and in consequence abstracts sufficient heat to cause the remaining part of the liquefied carbonic acid to solidify. The gaseous carbonic acid may be returned to the pumps. The solidifying chamber may be made fixed or moveable; it is provided with a discharging door for the solid carbonic acid, and is coated with non-conducting material. Boxes, bags, or the solidifying chamber itself may be used for transporting the solid carbonic acid.—H. A.

Improvements in the Preparation of Anhydrous Oxide of Barium, or other Substances of Like Properties, for Use in the Separation of Oxygen and Nitrogen of Atmospheric Air. Brin's Oxygen Company, Limited, and K. S. Murray, London. Eng. Pat. 17,298, October 10, 1891.

Pieces of fire-clay, pumice stone, or other inert material are saturated with fused barium nitrate at a high temperature, which is maintained for some time to drive off volatile impurities. The pieces are allowed to cool in an air-tight chamber. The barium oxide so produced presents a large surface for subsequent action on air.—H. A.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Improvements in Apparatus for Washing Photographic Prints and Negatives. H. Holcroft, Wolverhampton. Eng. Pat. 19,706, November 13, 1891.

The improved apparatus consists in a cistern in which is fitted a carrier, provided with narrow ledges or corrugations to receive horizontal trays, upon which the negatives or prints to be washed are placed, the carrier is made somewhat shorter than the cistern in order to leave a water space at each end. The trays consist in frames on which a netting is strung. To prevent prints being washed out of the trays, vertical bars are fixed across the outflow end of the carrier, the ends of the trays being notched to correspond. Water is allowed to drip into one end of the cistern, flows over the surface of the prints or negatives, and escapes by an overflow [illegible]

[fol. 437] DEFENDANT'S EXHIBIT E 14

Roscoe & Schorlemmer, "Treatise on Chemistry," Ed. 5, v. 1, 1920

The Non-metallic Elements

After the dioxide had liquefied it was distilled over into the receiving cylinder.

Natterer,[1] of Vienna, and Bianchi, of Paris, later on constructed an apparatus in which carbon dioxide prepared in a separate vessel was compressed by means of powerful pumps into wrought-iron pear-shaped vessels, and this principle is still adopted, except that the wrought-iron vessels have now been replaced by cylinders of mild steel, which contain about 8 litres. These are chiefly filled in certain

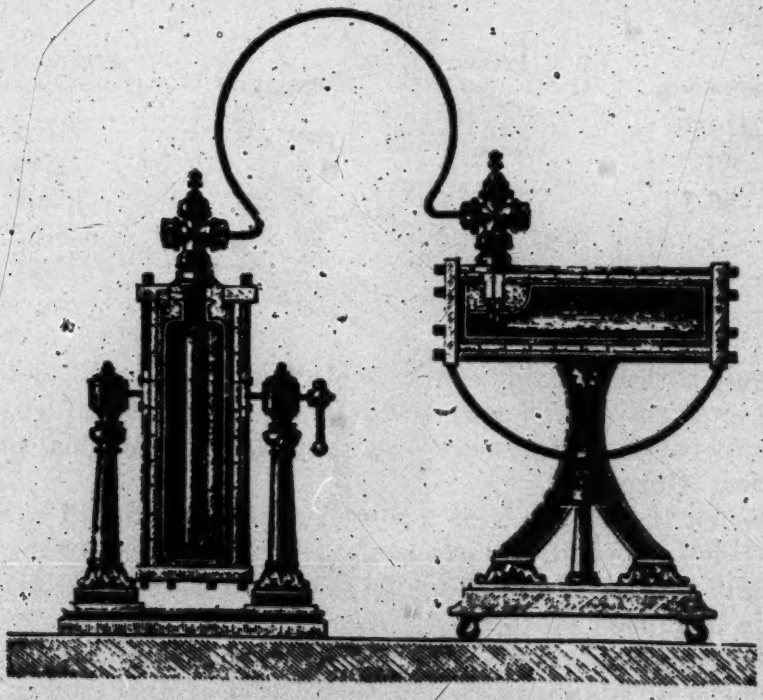

FIG. 189.

large breweries from the carbon dioxide given off during fermentation, and also from the gas evolved from certain

[1] J. pr. Chem. 1845, 35, 169.

springs such as those at Burghold on the Rhine, or from gas specially prepared in other ways (p. 805).

It is now largely sold and used for producing cold, as well as high pressures, and is therefore employed in the manufacture of cast steel. It is also employed for beer-engines, in the manufacture of salicylic acid, and for the production of aërated waters.

Liquid carbon dioxide is a colourless, very mobile liquid, [fol. 438] slightly soluble in water, upon the surface of which it floats. Its specific gravity is 0·9951 at —10°, 0·9470 at 0° and 0·8266 at +20°.[1] These numbers show that liquid carbon dioxide expands more upon heating than a gas, and its coefficient of expansion is larger than that of any known substance. The boiling point of liquid carbon dioxide is —80° under a pressure of 760 mm., and its vapour pressure at different temperatures is given in the following table:

Temperature	Pressure in mm. of mercury	Temperature	Pressure in mm. of mercury
—125°	5	+ 5°	30753
—80	760	+15	39646
—56·7	3876	+25	50207
—25	13007	+35	62447
—15	17582	+45	76314
— 5	23441		

Liquid carbon dioxide conducts electricity badly; it does not act as a solvent on most substances, does not redden dry litmus paper, and possesses no very striking chemical properties (Gore).

When the stopcock of a vessel containing liquid carbon dioxide is opened, a portion of the liquid which rushes out solidifies in the form of white snow-like flakes (Thilorier). This is caused by the absorption of heat, produced by the rapid evaporation of another portion of the liquid. For the purpose of obtaining larger quantities of this carbon dioxide snow, the apparatus shown in Figs. 190 and 191, suggested by Natterer, is employed. It consists of two brass cylinders, AB and CD, one of which can be fixed inside the other, each being fastened to a hollow non-conducting

[1] Andreef, Annalen, 1859, 110, 1.

handle. The liquid carbon dioxide is allowed to pass quickly from the nozzle of the cylinder containing the liquid through the tube d (the position of which inside the box is shown in Fig. 191). A portion of the liquid undergoes evaporation and passes out as gas through the fine holes in the handles, whilst the larger portion remains behind as a solid, finely divided, crystalline, bulky mass, capable of being pressed together like snow. It can also be readily prepared by blowing liquid dioxide into a bag of coarse canvas, which retains the solid, whilst allowing the liberated gas to pass away. Solid carbon dioxide, both in the compressed and snow-like form, evaporates very slowly in the air, be-

FIGS. 190 and 191

cause of the large amount of heat volatilisation required. [fol. 439] Notwithstanding its excessively low temperature it may be touched without danger, the gas which it constantly emits forming a non-conducting atmosphere round it. If, however, it be pressed hard upon the skin, solid carbon dioxide produces a blister exactly like that produced by contact with a red-hot body. This snow-like mass may be readily compressed in cylindrical wooden moulds. The solid mass thus obtained has a density of about 1-2, and requires a considerable time for evaporation in the air.[1] When solid carbon dioxide is mixed with ether, and the mixture brought into a vacuum of an air-pump, the temperature sinks to —110°. A tube containing liquid carbon dioxide brought into this solidifies to a transparent, ice-like solid mass (Mitchell and Faraday), the specific gravity of the ice-like solid being 1-56 at —79°.

A process has been patented for carrying out the manufacture of solid carbonic acid by a similar method on the large scale. The solid material may be transported in bags or casks, or in the iron chamber in which it is produced.[2]

Formula of Carbon Dioxide.—It has already been shown (p. 776) that carbon dioxide is formed by the combination of 12 parts of carbon with 32 parts of oxygen. Further, when carbon burns in oxygen to form the dioxide, the volume of the latter produced is equal to that of the oxygen used, and hence one molecule of the gas must contain two atoms of oxygen, this being in agreement with the formula CO_2, in which the atomic weight of carbon is taken at 12.

[fol. 440] DEFENDANT'S EXHIBIT E 15

Carbon

rend. 1893, 116, 386); and, according to Moore, liberates nitrous acid from nitrites (J. Amer. Chem. Soc. 1904, 26, 959). Solution of carbon dioxide in water yields sodium formate with metallic sodium (Kolbe and Schmidt, Annalen, 119, 251). Carbon dioxide is assimilated by the chlorophyll

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[1] Landolt, Ber. 1884, 17, 309.

[2] English Patent 13,684 (1891).

of plants under the influence of sunlight, carbon being abstracted and oxygen set free. Carbon dioxide diffuses through caoutchouc (Kobbe, Chem. Zeit. 1890, 14, 1142).

The specific heat of carbon dioxide is greater at high than at ordinary temperatures (Berthelot and Vieille, Compt. rend. 98, 770 and 852). According to Hoppe-Seyler (Zeitsch. physikal. Chem. 10, 201, and 10, 401), the carbonic acid and marsh gas found in water-logged soils is due to a widespread process of fermentation of cellulose.

In any working or living-room the carbon dioxide should not be more than 10 volumes per 10,000 of air.

To estimate the carbon dioxide in air, a measured sample of the air is passed through a known quantity of barium hydroxide, coloured with phenolphthalein, and by noting the quantity of air needed to decolourise the hydroxide the carbon dioxide can be calculated. The method is sometimes modified by using a limited volume of air, and titrating the hydroxide remaining unneutralised (Ballo, Ber. 1884, 1097; Wiener, Monatsh. 1894, 15, 429; Henriet, Compt. rend. 1896, 123, 125; Woodman, J. Amer. Chem. Soc. 1903, 25, 150; Jean, Compt. rend. 1902, 135, 746; J. Pharm. Chim. 1903, 27, 418; Pécoul and Levy, J. Soc. Chem. Ind. 1906, 655; Davies and McLellan, ibid. 1909, 232).

Carbon dioxide is used extensively in the arts for the manufacture of aërated waters, in sugar manufacture for separating lime from the juice of the sugar cane, in bread making, and for raising and clarifying beer.

It is also employed for protecting wines from moulds and acetifying organisms. It preserves their aroma and bouquet, and makes the wine fresher, sweeter, and stronger. Wines can also be revivified by the gas (Piaz, J. Soc. Chem. Ind. 1894, 266; 1903, 644; Pini, Bull. de l'Assoc. des Chim. 1898, 15, 741). It also possesses antiseptic properties and retards the putrefaction of meat (Kolbe, J. pr. Chem. [2] 28, 61). It has also been proposed to use it as a motive power where fuel is expensive (Herbert, Chem. Zentr. 1885, 543, 558, 572).

Mixed with acetylene (about 5-8 p. c.), it decreases the smokiness of the flame and prevents the clogging of the burners (J. Gas Lighting, 1898, 72, 916).

Liquid carbon dioxide (Büchner, Zeitsch. physikal Chem. 1906, 54, 665) can be obtained in large quantities by an

apparatus described by Thilorier (Annalen, 30, 122). Natterer compressed carbon dioxide by a specially constructed air-pump (J. pr. Chem. 35, 169); v. also Gore, Phil. Trans. 1861, 63). It is prepared from bisulphates by the action of carbonates, the apparatus consisting essentially of a leaden vessel containing a solution of the bisulphate and having a stirring apparatus and gear fixed air-tight to it. By means of a tube and pump an equivalent quantity of calcium carbonate (obtained as a waste product in the manufacture of caustic soda) suspended in water in a second vessel is forced in and the stirrer set in motion. The liberated carbon dioxide is dried and passed into a gasometer from which it is afterwards condensed. An apparatus is also described which allows the evaporation and expansion of liquid carbon dioxide to take place round a tube containing a solution of calcium chloride. The latter is so cooled that it may be used for the manufacture of ice. The carbon dioxide thus used is passed over moist sodium carbonate, converting it into bicarbonate, which may be again used in the carbonic acid manufactory (Thomas, Zeitsch. angew. Chem. 1900, 386). (For description and figure of apparatus for liquifying CO_2 and for bottles in which it is stored and sold, see Sisson, J. Soc. Chem. Ind. 1904, 242.)

Liquid carbon dioxide may be bought in iron or steel bottles containing 8 kilos. (about 4000 litres of the gas at ordinary temperature and pressure), costing about 1 sh. per kilo. It furnishes the cheapest means for aërating waters, and is used for raising sunken ships, for driving torpedoes, for extinguishing fires, for cooling purposes, and, as 'Pictet's fluid,' for freezing machines, and by the firm of Krupp, in Essen, for the condensation of steel and other metals, and is further suggested as a motive power for tramcars and balloons (J. Soc. Chem. Ind. 4, 610):

It is also used for making carbonates and other chemical products, for filtering and sterilizing organic liquids (d'Arsonval, Compt. rend. 1891, 112, 667), and in Germany for the generation of pressure on storage casks of beer to the faucets above where the beer is drawn for consumption. In Engineering, Dec. 3, 1903, a description is given of its use in railway signaling in outlying stations, to supply the motive power for working the signals, so as to avoid the ex-

pense of compression machinery or of long lengths of connecting pipes.

Liquid carbon dioxide is colourless, very soluble in alcohol, ether, and volatile oils, but does not mix with water. When the pressure is suddenly relieved, part of the carbon dioxide immediately vaporises, producing sufficient cold to solidify the remainder. Landolt allows the liquid to evaporate freely into woollen bags, and compresses the solid carbon dioxide in conical wooden moulds by wooden pistons (Ber. 17, 309); cf. Purcell (J. Soc. Chem. Ind. 1892, 936; Eng. Pat. 13684, 1891). A vessel for storing solid carbon dioxide is described by Heyl and Wultze (J. Soc. Chem. Ind. 1904, 1215; French Pat. 344957, 1904).

An apparatus for obtaining small and large quantities of solid carbon dioxide is described by Fechlu (J. pr. Chem. 1903, 67, 423; J. Soc. Chem. Ind. 1903, 626); also by Elsworthy (J. Soc. Chem. Ind. 1905, 1231). (For an apparatus for collecting solid carbon dioxide, v. Ducretet, Compt. rend. 99, 235.)

Solid carbon dioxide is a white, flocculent, snow-like mass, melting at —56.7° at 5 at atmospheres pressure, and may be left exposed to the air for some time without sensible evaporation. An air or spirit thermometer immersed in it sinks to —79°; it can, however, be placed on the hand without any acute sensation of cold. By mixing with ether its refrigerating power is greatly increased. This is denied by Villard and Jerry (l. c.) but the temperature sinks to

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[fol. 441] DEFENDANT'S EXHIBIT E 16

Carbon with Hydrogen and Oxygen

This liquid does not redden blue litmus paper nor possess any striking chemical properties.

It can readily be obtained in a solid form, like snow, by allowing some of the liquid carbon dioxide to escape from the exit valve of a cylinder into a cloth bag, the cold, produced by the sudden expansion of part of the liquid, condensing the rest into a solid form. Solid carbon dioxide melts at —65°, a point above its normal boiling point. If

mixed with ether and allowed to evaporate under an air pump, the temperature will be reduced to —110°.

Chemically, carbon dioxide is a very stable compound, decomposing into carbon monoxide and oxygen only at a very high temperature, or, in minute quantities, under the influence of the electric spark. It will not, as a rule, support combustion, but a piece of magnesium tape or wire, once ignited, will continue to burn in it, forming magnesium oxide, and leaving a black deposit of carbon. It will also attack heated metallic sodium or potassium, forming alkaline carbonates, and liberating carbon.

It dissolves readily in water, at ordinary temperatures, one volume of water absorbing one volume of the gas, the proportion by weight increasing in accordance with the pressure.

This solution must be considered as, to some extent at least, a chemical combination, for in such a solution there is always contained in a diluted form a certain quantity of a dibasic acid, carbonic acid, H_2CO_3. This is shown by the fact that wet carbon dioxide, or an aqueous solution of the same, reddens blue litmus paper, a property not shared by the dry gas. This acid is decomposed readily by heat or even by evaporation into carbon dioxide and water. Hence the litmus-paper, reddened by carbonic acid, again becomes blue on drying.

This acid, having two replaceable hydrogen atoms in its molecule, is able to form two different sets of salts, namely, the carbonates, and the acid or bi-carbonates. In the former, both hydrogen atoms are replaced by metals, and in the latter only one hydrogen atom is replaced. The bi-carbontes can be

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(Here follow photostats of side folios 442 and 443)

[illegible]

1 hr run

98.7
97.1
1.6

1.6 B NH3 — 83 lbs 13. fan 11.
at 5.04.2 71.1

5 Bbl. — Ent Cu 71 Br - 20

CO2

Cooled T.6 - 41

Took out 4 weighed 5.81 lb. CO2

End of stream 2.18 — Start 7.325

Air 71 Br any - 40

97 / 40 — 2.32 lb CO2 — Need 1 40
1.6 NH3 — 20

116 / 20 — ~~2.32 of 40 = 1.92~~
1 Lb NH3 at 10 cents 1.60
7.92 CO2 at 6¢ 13.92
1
CO2 NH3 Bbl 97
Ny 116

~~116 / 232 0.50~~ 97 / 100 .60
2 10
240 .1

706

DEFENDANT'S EXHIBIT G 443

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930 42 47.83
10 44 20.67 Ob
1031 43
11 42
1130 42
12 42
1233 42
1 43
5 | 424
47.33 Ky

628
43c
Net Ins. 1.98 Ky

Ice Box cooled to 48.5

Avg 10 & 2 hours 48. and 76. Ob 26

Ratio 3.78 Ky

1.98 Ky 4.78 for 20.67 Ob | 2.37
378 9.44 — 26 Ob | 33.76.
.422 Zero 80
1 " 5 .5

[fol. 444] DEFENDANT'S EXHIBIT H 1

N° 13,684 A.D. 1891

Date of Application, 13th Aug., 1891

Complete Specification Left, 13th June, 1892—Accepted, 8th Aug., 1892

Provisional Specification

An Improved Process and Apparatus for the Manufacture of Solid Carbonic Acid (CO_2)

We Charles Robert Clarke Tichborne LL.D, F. I..C. of 15 Great Georges Street, Dublin, Alfred Edward Darley of Ardee Street, Dublin, Brewer, Samuel Geoghegan of St. James Gate Brewery Dublin, C. E., and Marmaduke Francis Purcell, B.L. F.C.S. Assoc. Inst. C. E. of I. 71 Harcourt Street, Dublin, do hereby declare the nature of this invention to be as follows:—

Our invention relates to a process and apparatus for the economical production of solid CO_2, utilizing the refrigerating effect of the expansion of part of the compressed or liquefied CO_2 to convert a proportion of the said CO_2 into a solid form, and this we effect without loss of the gas to any appreciable extent.

To carry our process into operation we employ a set of stage compressors, driven by any suitable power, to compress a supply of CO_2 gas (obtained from any convenient source) to a sufficient pressure to cause liquefaction of the said gas, aided by the action of a surface condenser to remove the heat accumulated in the said gas during the process of compression. The liquid CO_2 so obtained is allowed to pass and be released from pressure into a separate jacketed chamber with non-conducting coating. The liquid thus in part becomes again a gas and in part becomes solid CO_2 under the refrigerating temperature produced by the expanding gas.

The said solid CO_2 may be collected by a suitable door or exit from the said chamber, and the gaseous portion of the CO_2, collecting in the upper portion of the chamber, may be returned again to the suction pipe of the pump where it will be re-drawn into the pump, and once more passed with a new charge through the same process of compression, liquefaction, & part solidification, as described above.

Or the gaseous CO_2 may b allowed to escape from the solidifying chamber, so as to be utilized for any suitable or convenient purpose.

The solid CO_2 or snow may be collected into boxes, bags or suitable vessels, provided with non-conducting coatings, for its handling or transport, or the solidifying chamber may be so made & mounted that it can be detached from the apparatus, & used as a vessel or wagon in which the solid CO_2 may be transported.

Dated this 13th day of August 1891.

Fell & Wilding, 1, Queen Victoria Street, London, E. C., Agents for the Applicants.

Complete Specification

An Improved Process and Apparatus for the Manufacture of Solid Carbonic Acid (CO_2)

We Charles Robert Clarke Tichborne LL.D. F.I.C. of 15 Great Georges Street, Dublin, Alfred Edward Darley, of Ardee Street, Dublin, Brewer, Samuel Geoghegan of St. James' Gate Brewery Dublin C.E. and Marmaduke Francis Purcell, B.L. F.C.S. Assoc. Ins. C. E. of I. 71 Harcourt Street Dublin, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

Our invention relates to an improved process and appa- [fol. 445] ratus for the economical production of solid CO_2 utilizing the refrigerating effect of the evaporation of a part of the liquefied CO_2 to convert a portion of the said CO_2 into a solid form, and this we effect without loss of the gas to any appreciable extent.

In order that our invention may be the better understood, we will now proceed to describe the same, reference

being had to the drawings hereunto annexed, and to the letters and figures marked thereon.

Figure 1 is a sectional view of our apparatus for carrying our process into effect

To carry our process into operation we employ a set of stage compressors A A A driven by any suitable power to compress a supply of CO_2 gas (obtained from any convenient source by the suction pipe a) to a sufficient pressure to cause liquefaction of the said gas. The liquefied gas is then carried into a surface condenser B for the removal of the heat accumulated in the said gas during the process of compression. The liquid CO_2 so obtained and cooled is allowed to pass by the pipe b and controlling cock c, and be partly released from pressure, into a chamber D, either with or without a non-conducting coating or heat-impervious jacket. The liquid thus in part becomes again a gas and in part becomes solid CO_2 G is a shield to prevent undue choking of the holes of the strainer at end of pipe F.

The said solid CO_2 may be collected by a suitable door E or exit from the said chamber L and the gaseous portion of the CO_2, collecting in the upper portion of the chamber, is returned again by the pipe F to the suction pipe a of the pumps, where it will be redrawn into the pumps A, and again passed either with a new charge through the same process of compression, liquefaction, and part solidification, as described above, or it may be simply passed to the compressors again for the purpose of getting a further quantity in the solid form as often as is necessary. Or the gaseous CO_2 may be allowed to escape from the solidifying chamber so as to be utilized for any suitable or convenient purpose.

The solid CO_2 may be collected into boxes, bags, or suitable vessels, provided with non conducting coatings, for its handling or transport; or the solidifying-chamber D may be so made and mounted, that it can be detached from the apparatus, and used as a receptacle or wagon in which the solid CO_2 may be transported.

Or the lower part of said chamber or a 2nd chamber may be made removable if required.

It is obvious that the refrigerating chamber D whether fixed or movable may be attached by a suitable supply pipe

and cock therein to the condenser and by a return waste pipe to the pump suction, or vat, of the generating, purifying, compressing and condensing apparatus for the collection of CO_2 from brewers fermenting vats, as patented to us under Nos. 3707 of 1889 and 9183 of 1890, and thus represent the same combination of apparatus and for the same purpose as before described.

Having now particularly described and ascertained the nature of our invention and in what manner the same is to be performed we declare that what we claim is:—

1st. A process for the manufacture of solid carbonic acid, consisting of a first compression of the said gas to a liquid form, the abstraction therefrom of the accumulated heat by condensation, and an elastic expansion of a portion of the compressed gas to absorb by the said expansion a large quantity of heat, to reduce the temperature of the remaining gas or liquid, rendering the same solid, the gas so expanded being returned without waste for further re-compression, substantially as described.

2nd. In a process for the manufacture of solid carbonic acid a series of stage compressing pumps drawing by suction a supply of CO_2 and compressing the same to a liquid form, in combination with a condensing and cooling still, pipe connections, and cocks or valves therein, and a refrigerating chamber or movable receptacle, with or without lagging or protection from absorption of heat, and pro-
[fol. 446] vided with a removable door for the extraction of the solid CO_2, and a return pipe and strainer for the return of the expanded gas back to the suction of the compressing pumps, or to the fermenting vats, or gas receiver, substantially as described.

3rd. In a process for the production of solid CO_2 a refrigerating receptacle either lagged or unprotected from the absorption of heat, connected by suitable pipes with cocks or valves therein, to the condenser, compressing pumps and any source of carbonic acid gas or to a compressed gas or liquid reservoir, the said receptacle being readily detached and mounted so as to be movable for the commercial distribution of the said solid carbonic acid.

4th. The combination with the generating, compressing, purifying, and condensing apparatus, for the collection of CO_2 from fermenting vats, as patented to us under Nos.

A.D. 1891. Aug. 13. N° 13,684. 13684
FICHBORNE & *others'* COMPLETE SPECIFICATION. (1 SHEET)

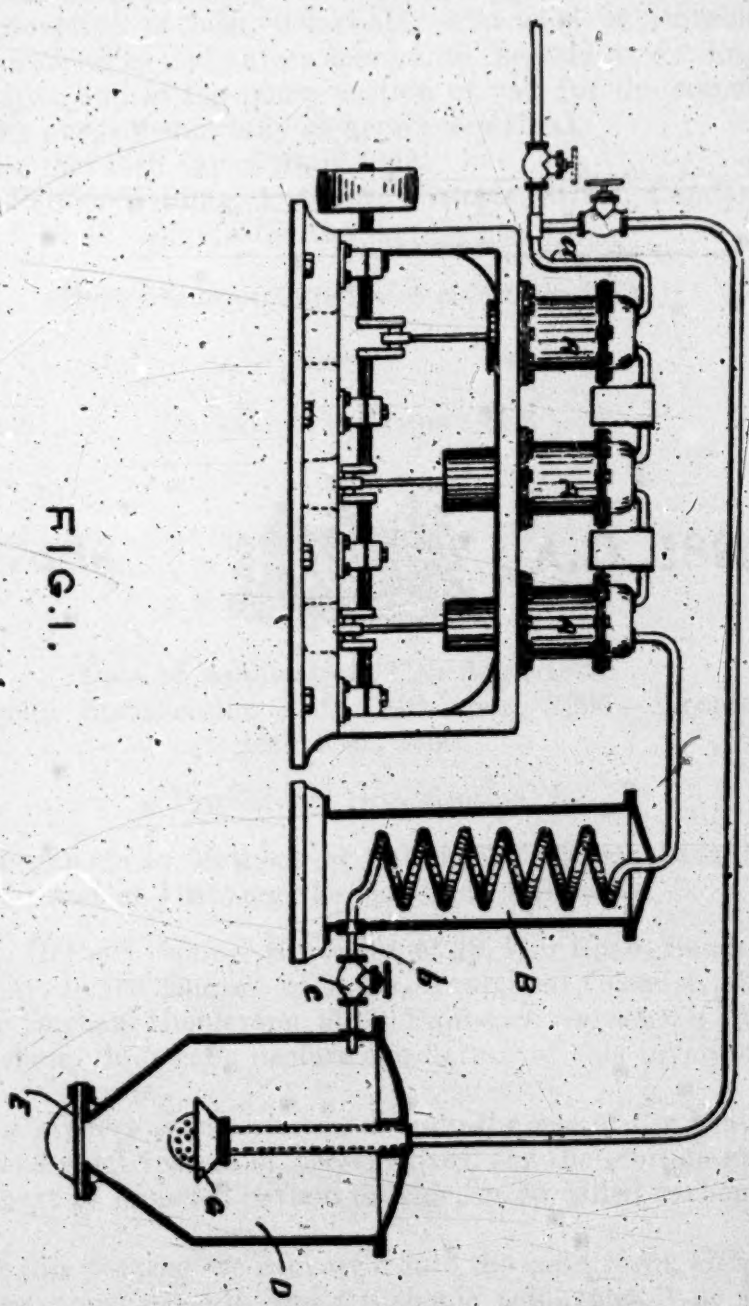
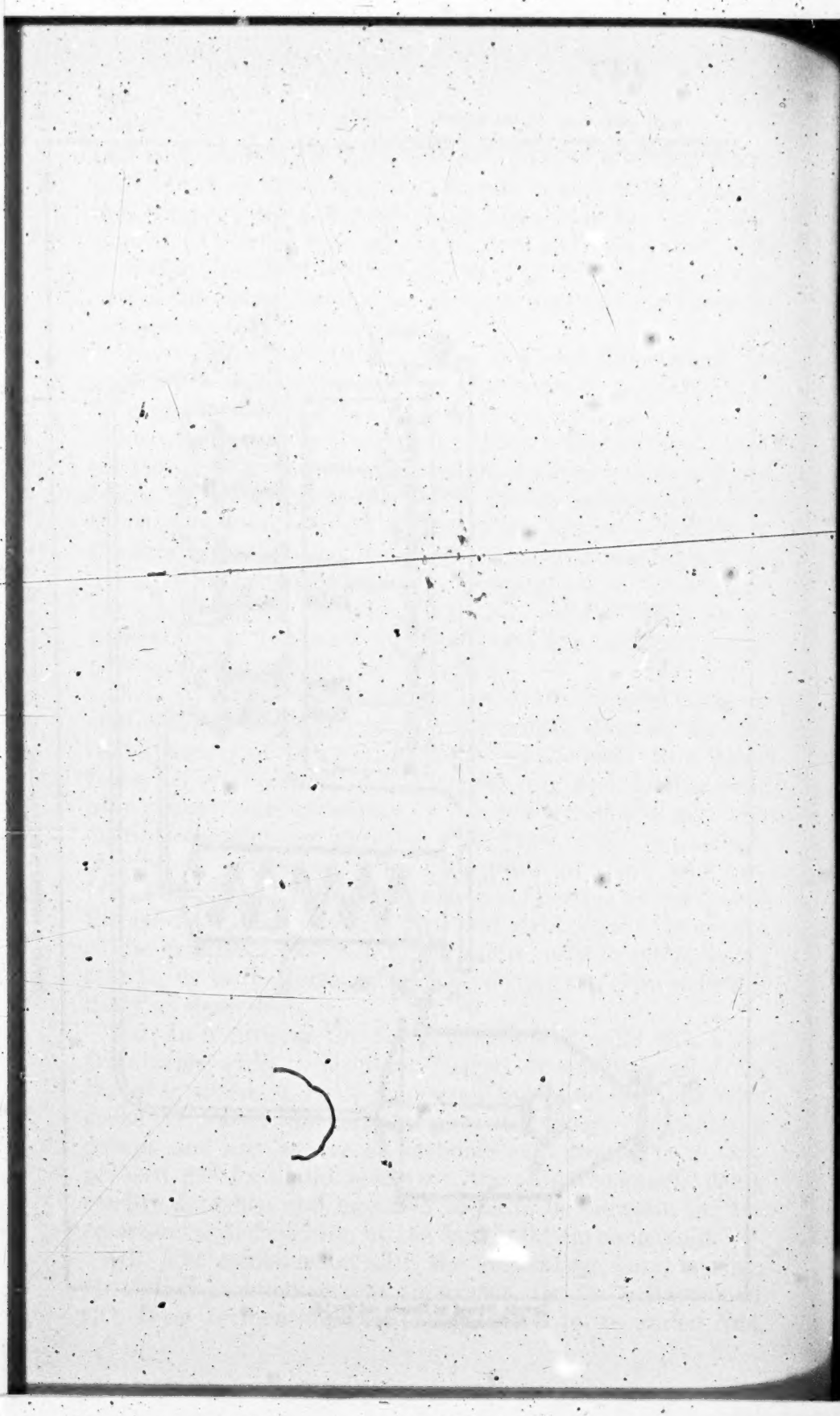


FIG. 1.

[This drawing is a reproduction of the Original on a reduced scale]

London: Printed by Darling and Son, Ltd.
for the Majesty's Stationery Office. 1892



3707 of 1889, and 9183 of 1890, of a fixed or movable refrigerating receptacle, either lagged or unprotected from the absorption of heat, detachably connected by suitable pipes, with cocks and valves therein, to the said condensing apparatus, and to the pump suction or vat, for the return of waste gas, substantially as herein described.

Dated this 13th day of June 1892.

Fell & Wilding, 1, Queen Victoria Street, London, E. C., Agents for the Applicants.

(Here follows photostat of side folio 447)

[fol. 448] DEFENDANT'S EXHIBIT H 2

N° 7436 **A.D. 1895**

Date of Application, 11th Apr., 1895
Complete Specification Left, 13th Jan., 1896—Accepted 15th Feb., 1896

Provisional Specification

Improvements in Methods of Solidifying Carbon Dioxide, and of Utilizing the Solidified Substance

We, Herbert Samuel Elworthy, of 19, Hill Road, Bandra, Bombay, in the Empire of India, Analytical Chemist, and Philip Durham Henderson, of 89, Philbeach Gardens, S. W., Gentleman, do hereby declare the nature of this invention to be as follows:

This process is intended to obviate the use of the heavy iron and steel vessels at present used, for the storage and transport of liquefied carbon dioxide, or so called carbonic acid.

For this purpose we convert it into the solid form, either by first converting it into "carbonic acid snow," or by freezing the liquefied gas direct, to a form resembling ordinary ice, both of which processes may be carried out, in the manner hereinafter described.

In order to carry out the first part of this process namely, converting the liquefied gas into "snow," we connect the outlet nozzles of the compressor direct to a coil, or worm, or series of coils or worms, or convolutions of pipes, enclosed in a larger pipe, or chamber, or room, or other suitable receptacle, which pipe, chamber, room or other receptacle, may be jacketted with a non-conducting material applied either direct, or placed between two casings. We prefer, however, to use a double walled pipe, in which the coil, or series of coils, may be placed. The chamber formed by the double walls of the pipe, may be of any suitable dimensions, and hermetically sealed, and the space in them exhausted, so as to form as complete a vacuum as possible, preferably in the manner proposed and used, by Professor Dewar, in his late researches, at the Royal Institute, though any other method of producing a good vacuum may alternatively be used.

The end of the coil, or coils, may now be conducted into a chamber, which may also be vacuum-jacketted, or protected in any other suitable way. The liquefied gas is allowed to escape into this chamber, through a nozzle, and by the sudden expansion, a large proportion of the liquid is converted into "snow," whilst the remainder at a very low temperature, is returned through the external double-walled pipe, enclosing the coil, either direct to the gas holder, for re-compression, or preferably through a jacket surrounding the cylinders of the compressor. In this way the gas, which is at an extremely low temperature, first cools the liquefied gas contained in the coils, leading from the compressor, to such an extent that a much larger proportion of the liquid is converted into snow, on expansion in the chamber, and finally acts as an exceedingly efficient means of cooling the compression cylinders of the pump, whereby it is possible to liquefy the gas, at a comparatively low pressure.

Instead of conducting the liquefied gas direct into the above-mentioned chamber, it may be conducted to a suitable pump motor cylinder, where, by its expansion, it may be caused to assist in the compression of another portion of gas, and finally be allowed to escape into the above-described chamber. In this way, the first expansion taking place, whilst the gas is doing work, a very considerable

cooling of the gas takes place, before it is sent into the chamber, and a much larger proportion of the liquid is, in consequence, solidified. After expansion in the chamber, the gas still remaining is sent through the pipe and the compressor jacket.

[fol. 449] The snow may be removed from the chamber, either at intervals, or continuously, by means of a conveyor screw, or other suitable means, and compressed by hydraulic, or other power, direct to solid blocks, or in the manner hereinafter described.

Instead of first converting the liquefied gas into snow, the highly cooled liquid, passing out of the coil, may be allowed to run into a vessel of any suitable form and which may be made strong enough to withstand the necessary pressure.

Round this vessel is coiled a sufficiently large pipe fitted at one end with a nozzle and regulating valve, and open at the other end, which is in free communication with the double-walled pipe, jacketting the coil from the compressor. This coiled pipe, is enclosed in an outer, double-walled vacuum, having a high vacuum between the walls, preferably formed by Professor Dewar's method, or a modification of it. The space in which the coil rests may either be filled with air, or a liquid which will not freeze at the solidifying temperature of carbon dioxide; such as pure alcohol.

The liquefied gas, coming from the compressor coils, is allowed to run into the inner vessel, at a sufficient pressure to keep it liquid, whilst a small proportion is allowed to escape, by means of a bye-pass, into the coil surrounding the vessel. In this way, the expansion of the gas, in the coil of pipe, which should be of rather large size, so as to get the full effect of the expansion on the surrounding air or liquid, is cooled to such an extent that the liquefied gas contained in the inner cylinder, is solidified. The cylinder may then be removed and the frozen carbon dioxide taken out in any suitable way.

The solid carbon dioxide, either in the form of snow or broken ice, may be compressed into any of the following forms, for convenience of manipulation, and thus rendered available for nearly all purposes for which ice is now used, as well as for many other purposes, amongst which will be

the manufacture of aërated waters, or other beverages, without machines of any kind.

The solidified dioxide, is compressed into the form of blocks or slabs, and these blocks or slabs may be scored, or divided, in such a way as to facilitate their being broken up into squares, or cubes, or tablets, or other forms of any suitable weight, and their weight, and also the quantity of gas they will produce, at atmospheric pressure, may be impressed on each block, either at the time of compression, or at a subsequent operation. In this way a known weight, or volume, may be readily broken off, and sold, or used in an ordinary ice box, or in the improved form of ice box, hereinafter to be described. This form of the solid, is also useful for providing the gas, in the present type of aërating machines, as any desired quantity can at once be placed in the gas holder of such a machine, whereby, on volatilization, it will be ready for use in the ordinary way.

Instead of compressing it into the form of large slabs or blocks, the solidified dioxide may be compressed into thin sheets, or slabs, and these slabs may be so constructed, that they may be readily broken up into sticks, rods, tablets, or other small pieces. For the manufacture of aërated beverages without a machine, these pieces may be of such a size, so as to give off the proper quantity of gas to aërate the water in any given bottle. Each of the pieces may be stamped with the weight or volume of gas of which they consist, and also with the size of bottle which they will aërate. By simply dropping one of these pieces into a bottle of water, and shaking it by hand, or by a simple rocking machine, the water will almost immediately become impregnated with the gas. In this way the aërating machine, with all its complications, is completely done away with.

By the use of this solidified gas, all danger from bursting storage vessels, is done away with, and also the large amount of freight now paid, for the transport of these vessels, the weight of which is from 2½ to 3 times the weight of the liquefied gas with which they are charged. The solidified gas can be carried in simple felt bags, or bags of other non-conducting material. It can also be stored or transported in an ordinary ice box, or in the improved form of ice box now to be described.

[fol. 450] These improved ice boxes are made with either double or triple walls. The two inner walls may be of metal, or glass, and these may be so secured together that the joints are absolutely air-tight. The walls should have as few points of contact as possible. The space between the walls is now exhausted, and the highest possible vacuum produced, either by Professor Dewar's method, or any other method capable of giving a very high vacuum. In order to protect the box from injury, and to further increase its non-conducting power, the box may be enclosed in an outer case of wood, paper boards, or any other strong non-conducting material, or of metal, and if preferred the space between this outer box and the internal one, may be filled with non-conducting material.

By these improved means of preparing, and transporting, solidified carbon dioxide, this material will be rendered available for all, or nearly all, purposes for which ice is now used, as well as for any other purposes for which the latter is unsuitable. By placing a small quantity of the solidified gas in a small box preferably made of silver, or aluminium, and which box may also contain ether, or alcohol, and immersing the box in any liquid or solution, the latter may be cooled without contact with the gas, and in this way the delicate bouquet of wines, and other liquors, is preserved. The box should have an escape tube, which may be of sufficient length, and of such a shape, as to act as a handle.

Dated this 10th day of April, 1895.

Edwards & Co., 65 and 66, Chancery Lane, London,
Agents for the Applicants.

Complete Specification

Improvements in Methods of Solidifying Carbon Dioxide and of Utilizing the Solidified Substance

We, Herbert Samuel Elworthy, of 19, Hill Road, Bandra, Bombay, in the Empire of India, Analytical Chemist, and Philip Durham Henderson, of 89, Philbeach Gardens, S. W., Gentleman, do hereby declare the nature of this invention, and in what manner the same is to be performed to be particularly described and ascertained in and by the fol-

lowing statement and accompanying drawings that is to say:

This process is intended to obviate the use of the heavy iron and steel vessels at present used, for the storage and transport of liquefied carbon dioxide, or so-called carbonic acid.

For this purpose we convert it into the solid form, either by first converting it into "carbonic acid snow," or by freezing the liquefied gas direct, to a form resembling ordinary ice, both of which processes may be carried out, in the manner hereinafter described.

The accompanying drawing is in illustration of the invention, Figure 1 being a side view, partly in section, of the apparatus which we employ in our improved process. b is an ordinary stage compressor, such as is now in general use for liquefying, or highly compressing, gases, and having the inlet pipe which brings the gas from the gas holder or producing plant to the first cylinder of the compressor, whence after passing through the cooling coils, and the other cylinders in succession, it passes away in a liquefied state to the regenerative-refrigerating apparatus B.

This regenerative-refrigerating apparatus consists of a double-walled vertical or horizontal vessel, this vessel may have an outer non-conducting covering 2, of any suitable material, and has between its double walls a space d which is exhausted in as complete a manner as possible, thus [fol. 451] forming a vacuum-jacket. Inside the refrigerating vessel the coil of pipe c is placed. The vessel is fitted into the base 8, and any spaces may be filled with non-conducting material. The vacuum-jacket is exhausted through the pipe 5, which is afterwards closed by means of a good valve or stop-cock. The liquefied gas coming from the compressor enters through the coil c through the pipe a and after passing through, is carried away by pipe e to the motor cylinder C^1, whence it passes by pipe 12 to the chamber f. The gas remaining unsolidified in the solidifying chamber f (Figure 1) returns through pipe i, and passing through the regenerative-refrigerator, round the outside of the coil c, goes away by pipe 3 to cylinder C^2 of the combined motor-pump 1 where it is partially compressed by means of the expansion of another portion of liquefied carbon dioxide in the cylinder C^1, and is then returned to the com-

pressor b by pipe 4, the latter being preferably connected to the intermediate cylinder of the compressor.

In the combined motor-pump l, shown in outline in Figure 1, the liquefied gas coming from the regenerative-refrigerator coil c, first enters cylinder C^1, where, by its expansion, it drives the motor and pump, and is itself very greatly cooled in the operation, after which it is exhausted into the solidifying chamber f where it becomes partially solidified into the form of snow. The unsolidified gas first returns to the regenerative-refrigerator, to cool the liquefied gas, and thence back again to cylinder C^2 of the motor-pump, where after being partially compressed it is returned to the compressor as above described.

f is the double-walled solidifying chamber, also vacuum-jacketted, the bottom of the chamber is preferably made tapering, or funnel shaped as shewn, and leads direct into a hydraulic press, the ram or platten of which compresses any snow formed, into the removable box at m. The hydraulic press may however be entirely separate, and the snow being removed from the bottom of the solidifying chamber by any suitable means, may then be placed in the box, and compressed in the usual way. When the box at m is full, it may be removed and another be put in its place, and the slab of compressed snow may then be taken out. The liquefied gas, either direct from the regenerative-refrigerator, or after passing through the motor cylinder C^1, enters the solidifying chamber f at h by the pipe 12, and the unsolidified gas passes away by the pipe i, the baffle plate 10 serving to prevent the pipe being choked by particles of the snow being carried along with the escaping gas.

The snow may be removed from the chamber f, either at intervals, or continuously, by means of a conveyor screw, or other suitable means, and compressed by hydraulic, or other power, direct to solid blocks, or in the manner hereinafter described. Instead of converting the liquefied gas first into snow, the highly cooled liquid, passing out of the coil, may be allowed to run into a vessel of any suitable form (not shewn in the drawing), and which may be made strong enough to withstand the necessary pressure.

Round this vessel is coiled a sufficiently large pipe, fitted at one end with a nozzle and regulating valve, and open at

the other end, which is in free communication with the double walled pipe, jacketting the coil c from the compressor. This coiled pipe is enclosed in an outer, double-walled vessel, having a high vacuum between the walls, preferably formed by Professor Dewar's method, or a modification of it. The space in which the coil rests may either be filled with air, or a liquid which will not freeze at the solidifying temperature of carbon dioxide, such as pure alcohol.

The liquefied gas, coming from the compressor coils, is allowed to run into the inner vessel, at a sufficient pressure to keep it liquid, whilst a small proportion is allowed to escape, by means of a bye-pass, into the coil surrounding the vessel. In this way, the expansion of the gas, in the coil of pipe, which should be of rather large size, so as to get the full effect of the expansion on the surrounding air or liquid, is cooled to such an extent that the liquefied gas contained in the inner cylinder, is solidified. The cylinder may then be removed and the frozen carbon dioxide taken out in any suitable way.

[fol. 452] A somewhat modified method of making the carbonic acid "ice," is as follows (as illustrated in Figures 2 and 3):—

The liquefied carbon dioxide is run through a coil of pipe r, immersed in a tank s containing methylated alcohol or pure alcohol, the tank being made preferably with double walls o and p and vacuum jacketted as above described. The carbon dioxide direct from the compressor is allowed to expand in the coil of pipe, down to about 5 or 10 atmospheres, and in doing so the spirit in the tank s is cooled down to a very low temperature. In the tank are placed a number of covered metallic cylinders or boxes t, or other suitable vessels, with air tight covers, and the expanded gas is allowed to flow partly into these boxes by the pipes and valves x, where it is solidified into ice, by the cold produced by the expansion of the liquefied gas. The remaining portion of the expanded gas, from the coil, is first sent by the pipe w into the cylinder of a motor, driving an air or gas compressor, and caused to do work, by compressing another portion of carbonic acid gas, and in doing this work, great cold is produced, and the gas which is exhausted from the motor cylinder is at a very low temperature. This gas is then sent through the above described regenerative, double-

walled pipe, in which the coils c (Figure 1) from the compressor nozzles are placed and in consequence the gas going to the coil in the spirit tank, is cooled to a very low temperature before it reaches this coil, and therefore the cold produced by its expansion is greatly increased.

Carbon dioxide freezes to a solid under a pressure of from 5 to 10 atmospheres, at a temperature of about 87° Centigrade.

If found preferable in practice, the compressed or liquefied gas can first be caused to do work in a motor cylinder, and can then be allowed to expand still further in the coil of pipe immersed in the spirit tank, and in this way also great cold is produced. The re-expanded gas from the coil may also be caused to do work, as hereinbefore described.

When the solidifying boxes t have been filled with ice they are removed from the spirit tank, the pipes x being uncoupled, and allowed to stand in the air for a few minutes, and then opened, and the block of ice taken out, which can be readily done, as the walls of the box have become slightly warmed by standing in the air. The boxes are also made slightly tapering for the purpose of facilitating the removal of the ice blocks. The block may now be marked in the manner hereinafter described, and either be broken up for use in making the smaller slabs, or sent out in the state as removed from the box.

Instead of cooling the spirit in the tank with carbon dioxide, any other cooling medium may be used, such for instance, as air, ammonia, ether, or the so called "Pictet" fluid, which consists in a mixture of carbon dioxide, and sulphur dioxide, and in this case the carbon dioxide is simply compressed into the boxes immersed in the spirit tank, and any waste is returned by a suitable arrangement of pipes to the compressor, or the gas holder. Any two or more substances may be used for cooling the gas, or it may be partially cooled by its own expansion and further cooled by the action of the other substances.

The solid carbon dioxide, either in the form of snow or broken ice, may be compressed into any of the following forms, for convenience of manipulation, and thus rendered available for nearly all purposes for which ice is now used, as well as for many other purposes, amongst which will be

the manufacture of aërated waters, or other beverages, without machines of any kind.

The solidified dioxide is compressed into the form of blocks or slabs, and these blocks or slabs may be scored, or divided, in such a way as to facilitate their being broken up into squares, or cubes, or tablets, or other forms of any suitable weight; and their weight, and also the quantity of gas they will produce, at atmospheric pressure, may be impressed on each block, either at the time of compression, or at a subsequent operation. In this way a known weight, or volume, may be readily broken off, and sold, or used in an ordinary ice box, or in the improved form of ice box, [fol. 453] hereinafter described. This form of the solid is also useful for providing the gas, in the present type of aërating machines, as any desired quantity can at once be placed in the gas holder of such a machine, whereby, on volatilization, it will be ready for use in the ordinary way.

The compressing apparatus is indicated in Figure 1, m being a receptacle, below the chamber f, into which the carbonic acid snow passes, and is very forcibly compressed in the receptacle by means of a pressure ram actuated by a hydraulic cylinder n, valves of the usual kind being provided by which water under pressure can be admitted into the cylinder n. When the snow has thus been compressed, the ram is withdrawn and the block of carbonic acid ice removed.

Instead of compressing it into the form of large slabs or blocks, the solidified dioxide may be compressed into thin sheets, or slabs, and these slabs may be so constructed, that they may be readily broken up into sticks, rods, tablets, or other small pieces. For the manufacture of aërated beverages without a machine, these pieces may be of such a size, as to give off the proper quantity of gas to aërate the water in any given bottle. Each of the pieces may be stamped with the weight or volume of gas of which they consist, and also with the size of bottle which they will aërate. By simply dropping one of these pieces into a bottle of water, and shaking it by hand, or by a simple rocking machine, the water will almost immediately become impregnated with the gas. In this way the aërating machine, with all its complications, is completely done away with.

By the use of this solidified gas, all danger from bursting storage vessels, is done away with, and also the large amount of freight now paid for the transport of these vessels, the weight of which is from 2½ to 3 times the weight of the liquefied gas with which they are charged. The solidified gas can be carried in simple felt bags, or bags of other non-conducting material. It can also be stored or transported in an ordinary ice-box, or in the improved form of ice-box now to be described.

These improved ice-boxes are made with either double or triple walls. The walls may be of metal, or glass, and these may be so secured together that the joints are absolutely air-tight. The walls should have as few points of contact as possible. The space between the walls is now exhausted, and the highest possible vacuum produced, either by Professor Dewar's method, or any other method capable of giving a very high vacuum. In order to protect the box from injury, and to further increase its non-conducting power, the box may be enclosed in an outer case of wood, paper-boards, or any other strong non-conducting material, or of metal, and if preferred the space between this outer box and the internal one, may be filled with non-conducting material.

By these improved means of preparing, and transporting, solidified carbon dioxide, this material will be rendered available for all,—or nearly all—purposes for which ice is now used, as well as for many other purposes for which the latter is unsuitable. By placing a small quantity of the solidified gas in a small box preferably made of silver, or aluminium, and which box may also contain ether, or alcohol, and immersing the box in any liquid or solution, the latter may be cooled without contact with the gas, and in this way the delicate bouquet of wines, and other liquors, is preserved. The boxes should have an escape tube, which may be of sufficient length, and of such a shape, as to act as a handle.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. For the manufacture of solid carbon dioxide, the use, and application of the regenerative cooling apparatus, substantially as set forth, and illustrated.

2. The use of the vacuum-jacketted pipes, chambers or vessels, substantially in the manner and for the purpose set forth, and illustrated.

3. The combination of the gas compressor delivering the [fol. 454] liquefied carbon dioxide to the regenerative cooling apparatus, and expansion chamber, for the purpose of producing solidified carbon dioxide, substantially as set forth and illustrated.

4. For the manufacture of solid carbon dioxide, the combination of the gas compressor, delivering the liquid gas to a coil of pipe immersed in a tank containing alcohol and having non-conducting walls, in which tank the gas is allowed to expand, cooling the alcohol to a very low temperature, part of the expanded gas passing into separate ice vessels, and the remainder driving a gas compressor and after expansion passing through the double walled pipe in which the coils from the compressor are placed, substantially as set forth and illustrated.

5. The compression of the carbon dioxide "snow" or broken "ice," into slabs or cakes, divided in such a manner as to be easily broken into pieces of known weight or volume, substantially as set forth.

6. The marking or stamping of these pieces with their weight or volume, or the size of bottle which they will aërate, substantially as set forth.

7. The manufacture of aërated waters, or other beverages, by means of the solidified gas, without the use of a machine, or by the use of a simple rocking machine, substantially as set forth.

8. The cooling of beverages by means of a box or hollow vessel, containing a piece of the solidified gas, and either with or without alcohol.

9. The ice-box having double air-tight walls, in which as perfect a vacuum as possible is maintained, substantially as set forth.

A.D. 1896. April 11. N° 7436.
KILWORTHY & another's Complete Specification.

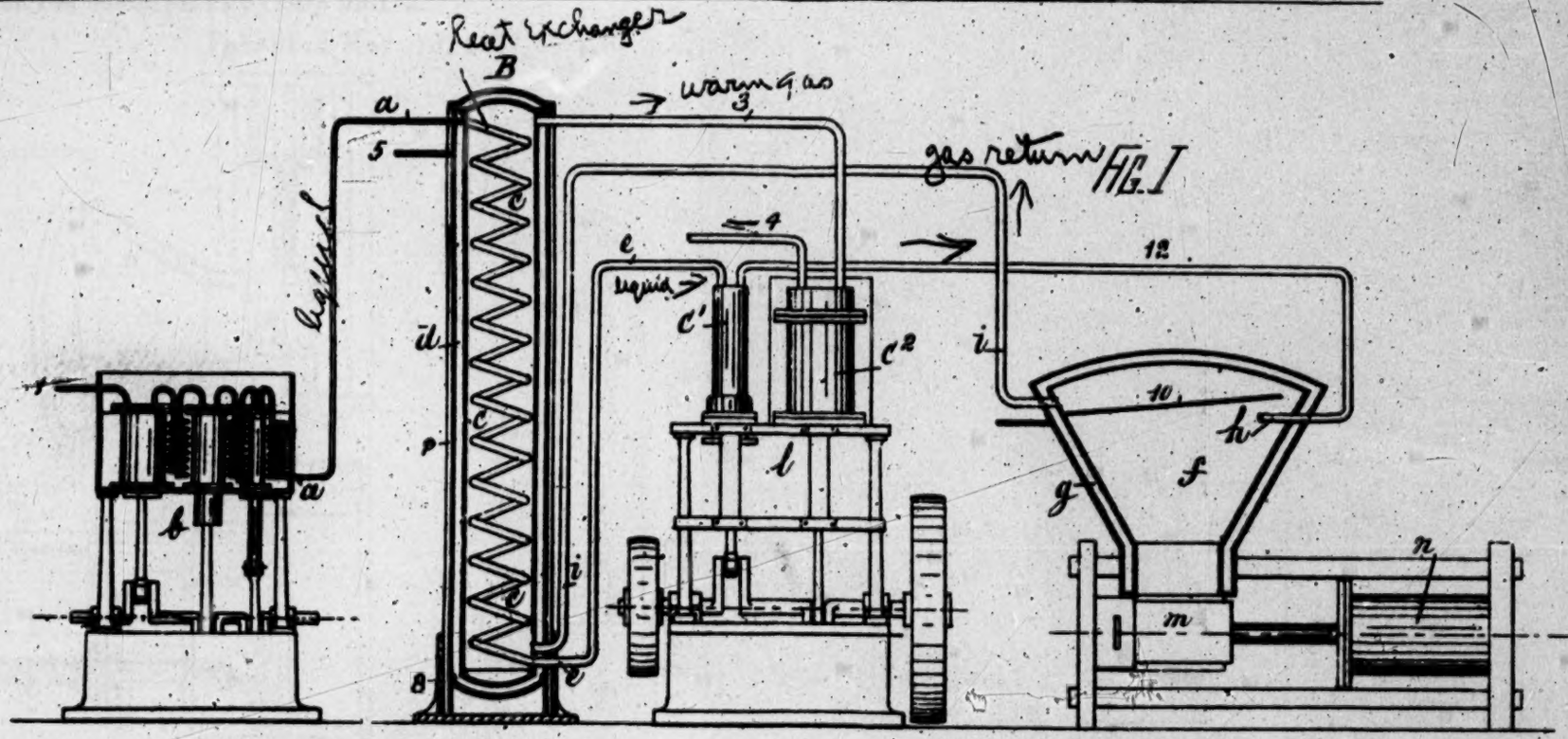


FIG. II

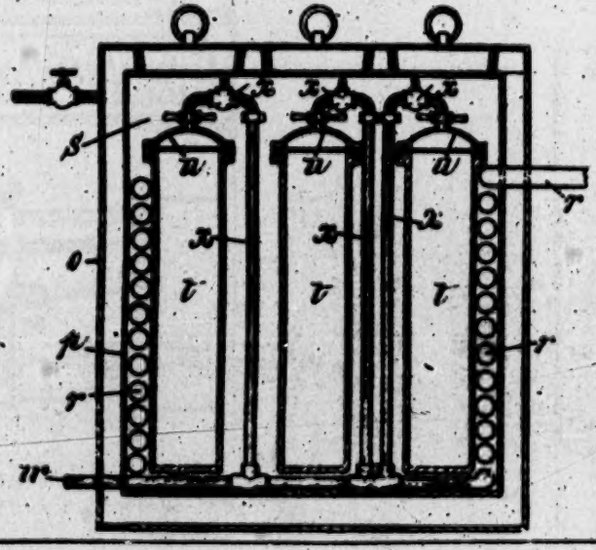
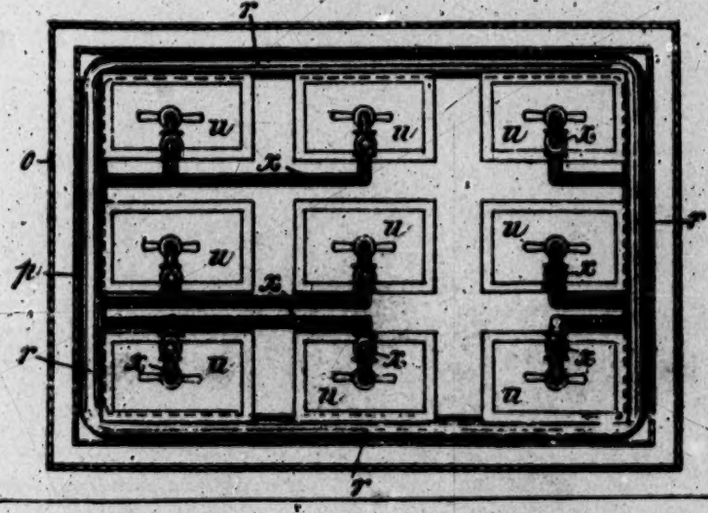
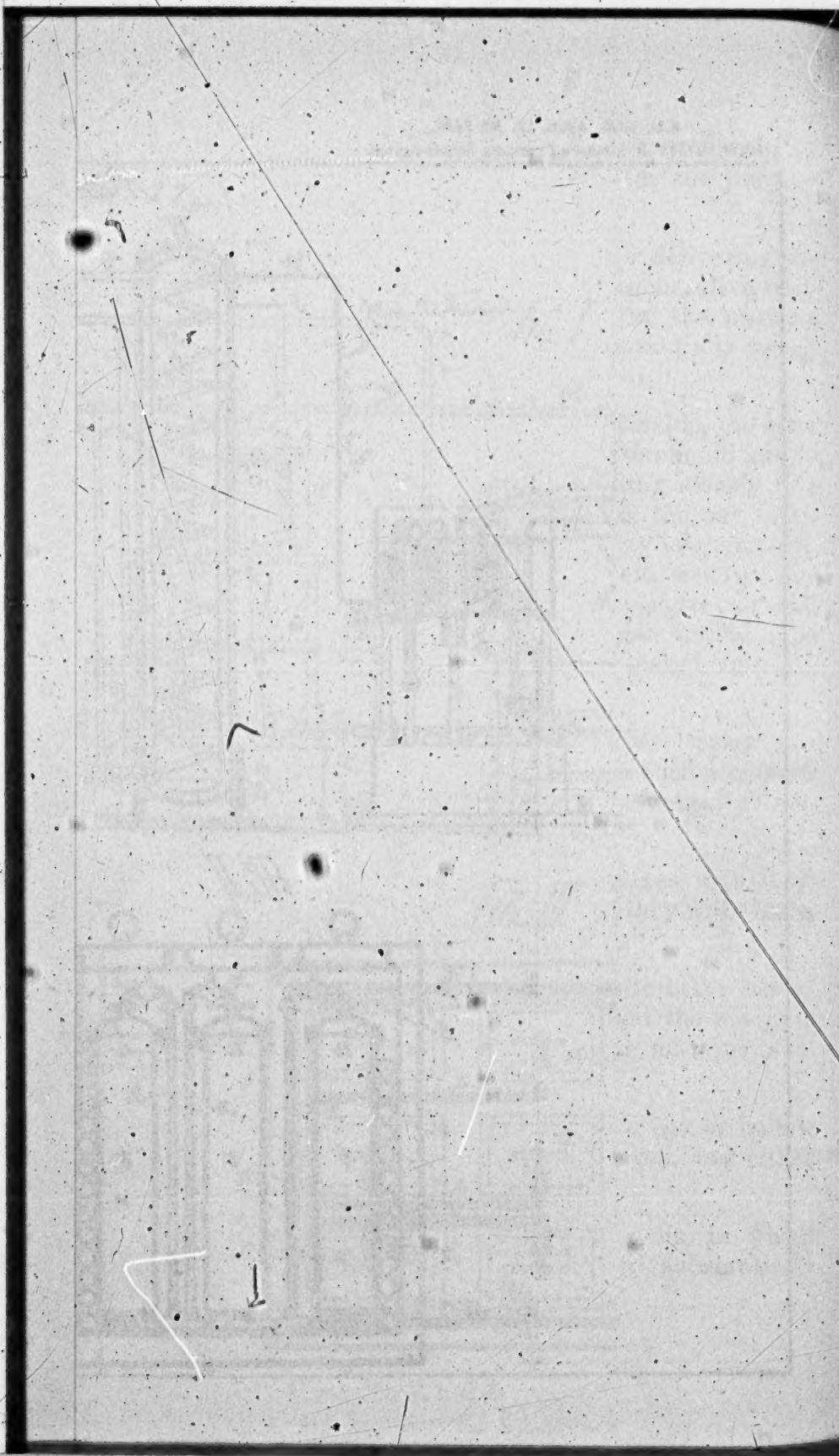


FIG. III





DEFENDANT'S EXHIBIT H 3

456

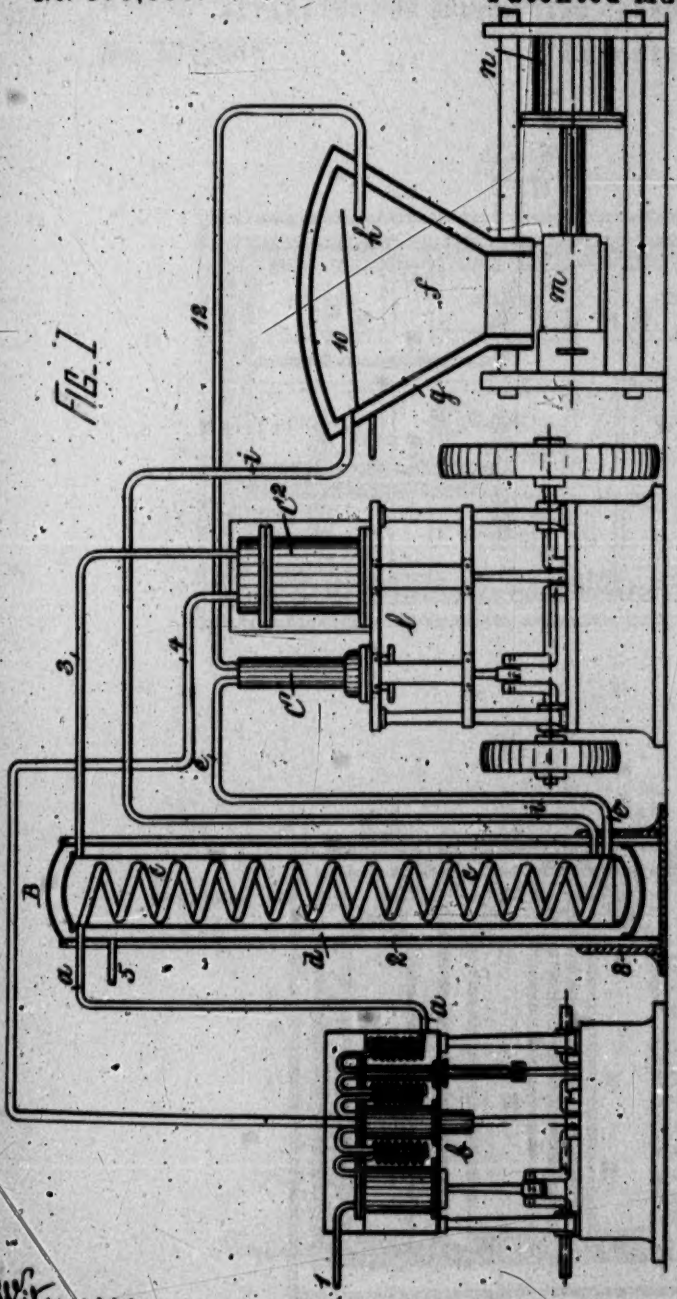
(No Model.) 3 Sheets—Sheet 1.

H. S. ELWORTHY.

APPARATUS FOR SOLIDIFYING CARBON DIOXID.

No. 579,866. Patented Mar. 30, 1897.

FIG. 1



Witnesses:
John H. Kalb
L. B. Yeates

Inventor:
H. S. Elworthy
by Whitman & Wilkinson
Attys.

457

(No Model.) 3 Sheets—Sheet 2.

H. S. ELWORTHY.

APPARATUS FOR SOLIDIFYING CARBON DIOXID.

No. 579,866. Patented Mar. 30, 1897.

FIG. II

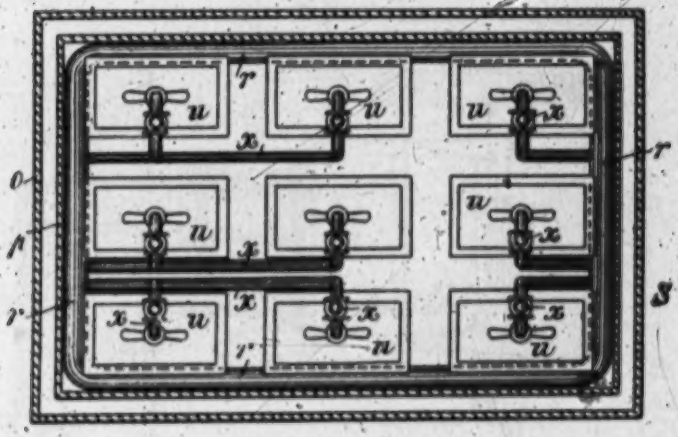
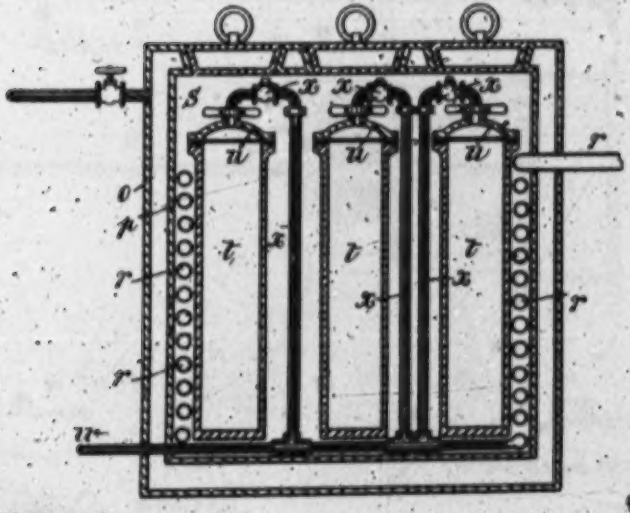


FIG. III



Witnesses:
John A. Holt.
F. B. Yeats.

Inventor:
H. S. Elworthy
by Whitman & Kellerman
Atty.

458

(No Model.) 3 Sheets—Sheet 3.

H. S. ELWORTHY.

APPARATUS FOR SOLIDIFYING CARBON DIOXID.

No. 579,866. Patented Mar. 30, 1897.

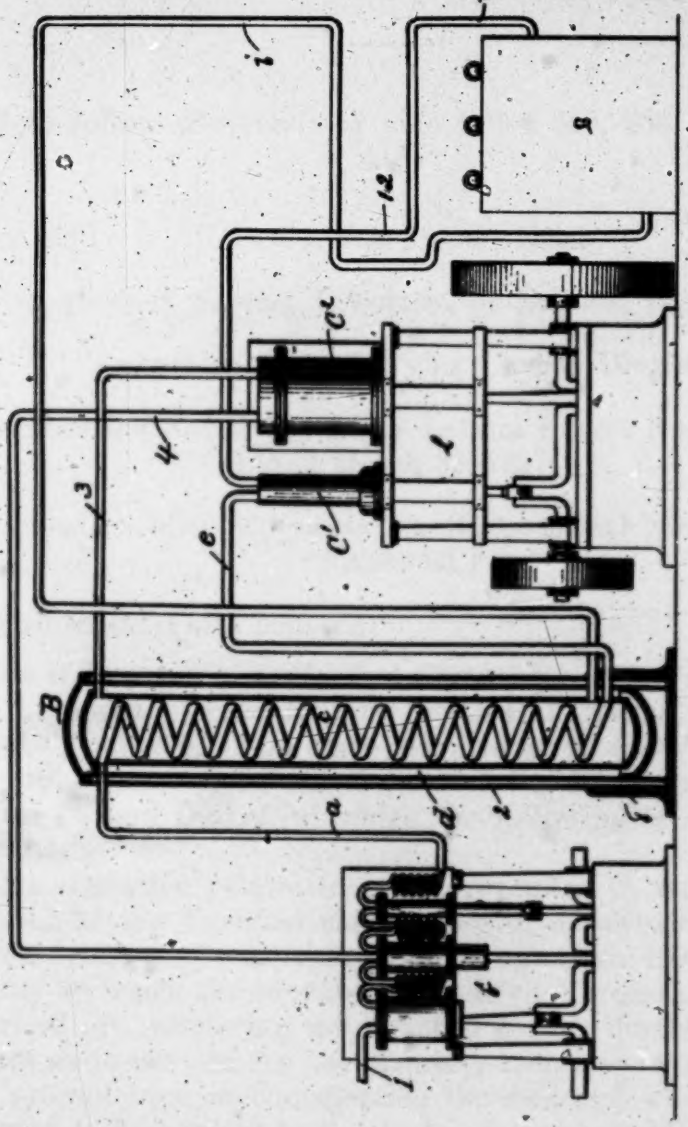


FIG. IV

Witnesses
John A. Hall
J. Stephen Cassatt

Inventor
H. S. Elworthy
by Whitman & Williamson
Attorneys

Dated this 13th day of January 1896.

Edwards & Co., 65 and 66, Chancery Lane, London,
Agents for the Applicants.

(Here follow photostats of side folios 455, 456, 457, and 458)

[fol. 459] United States Patent Office

Herbert Samuel Elworthy, of Bandra, India

Apparatus for solidifying Carbon Dioxid

Specification Forming Part of Letters Patent No. 579,866, Dated March 30, 1897

Application filed September 20, 1895. Serial No. 563,120. (No model.)

To all whom it may concern:

Be it known that I, Herbert Samuel Elworthy, a subject of the Queen of Great Britain, residing at Bandra, Bombay, in the Empire of India, have invented certain new and useful Improvements in the Method of Solidifying and Utilizing Carbon Dioxid, of which the following is a specification.

My invention relates to an improvement in the process of solidifying liquefied carbon dioxid, or so-called "carbonic-acid gas;" and it also relates to certain novel apparatus by which the process of solidifying aforesaid gas is carried out, rendering the liquefied carbon dioxid in such form as to obviate the use of heavy iron and steel vessels at present used in transporting the gas, and when transported to be applied to a variety of purposes hitherto attended with much trouble and inconvenience.

To more fully describe my invention, reference is had to the accompanying drawings of the apparatus for carrying out the aforesaid improved process, in which—

Figure 1 represents in side elevation, partly in section, the several parts of the complete apparatus for solidifying

carbon dioxid, consisting of a stage-compressor, regenerative refrigerating apparatus, a double-cylinder motor-pump, a solidifying-chamber, and a hydraulic compressor. Fig. 2 represents a horizontal section of a spirit-tank containing solidifying-boxes and piping, shown in plan, all of which may be substituted for the solidifying-chamber shown in Fig. 1. Fig. 3 represents a vertical cross-section through the apparatus shown in Fig. 2. Fig. 4 represents the compressor, regenerative device, and expansion-engine shown in Fig. 1 connected with the modified form of solidifying device as shown in Figs. 2 and 3.

Similar letters and numerals refer to similar parts throughout the several views.

The carbon dioxid is converted into a solid form either by first converting it into "carbonic-acid snow" and compressing that into blocks more or less solid, or by freezing the liquefied gas direct to a condition resembling ordinary ice. In order to carry out the first process—namely, converting the gas into "snow"—the gas-reservoir is connected by means of the pipe 1 to the stage-compressor b, which is the ordinary form of compressor now in general use for liquefying or highly compressing gases.

The gas passes into the first or largest cylinder of the compressor, whence, after passing through the cooling-coils and the other cylinders in succession, it passes away in a liquefied state via the pipe a to the regenerative refrigerating apparatus B. This regenerative refrigerating apparatus B consists of a double-walled vertical or horizontal vessel. This vessel may have an outer non-conducting covering 2, of any suitable material, and has between its double walls a space d, which is exhausted in as complete a manner as possible, thus forming a vacuum-jacket. Inside the refrigerating vessel the coil of pipe c is placed. The vessel is fitted into the base 8, and any spaces may be filled with non-conducting material. The vacuum-jacket is exhausted through the pipe 5, which is afterward closed by any suitable means. The liquefied gas coming from the compressor enters the coil c through the pipe a, and after passing through said coil is carried away by pipe e to the motor-pump cylinder C′, whence it passes by pipe 12 to the cylinder f. That portion of the gas which remains unsolidified in the solidifying-chamber f, Fig. 1, returns through the

pipe i, and passing through the regenerative refrigerator round the outside of the coil c goes away by pipe 3 to cylinder C^2 of the combined motor-pump l, where it is partially compressed by means of the expansion of another portion of liquefied carbon dioxid in the cylinder C′, and is then returned to the compressor b by pipe 4, the latter being preferably connected to the intermediate cylinder of the compressor.

In the motor-pump l (shown in outline in Fig. 1) the liquefied gas coming from the regenerative refrigerator-coil c first enters cylinder C′, where by its expansion it drives the motor and pump and is itself very greatly cooled in the operation, after which it is exhausted into the solidifying-chamber f, where it becomes partially solidified into the form of snow. The unsolidified gas first returns to the regenerative refrigerator to cool the liquefied gas, and [fol. 460] thence back again to cylinder C^2 of the motor pump, where after being partially compressed it is returned to the compressor, as above described.

f is the double-walled solidifying-chamber, also vacuum-jacketed, as at g. The bottom of the chamber is preferably made tapering or funnel-shaped, as shown, and leads direct into a hydraulic press. The snow formed in the chamber accumulates at the bottom thereof, and the ram or platen of the press compresses the snow thus formed into the removable box at m. The hydraulic press may, however, be entirely separate, and the snow being removed from the bottom of the solidifying-chamber by any suitable means may then be placed in the box and compressed in the usual way. When the box at m is full, it may be removed and another be put in its place, and the slab of compressed snow may then be taken out. The baffle-plate 10 serves to prevent the pipe i being choked by particles of the snow being carried along with the escaping gas.

Instead of using the solidifying-chamber and press shown in Fig. 1 the apparatus shown in Figs. 2, 3, and 4 may be substituted. In this case the pipe 12, conveying the liquefied carbon dioxid from the cylinder C′, may be connected direct to the coil-pipe r, which pipe is most clearly shown in Figs. 2 and 3.

This liquefied carbon dioxid is run through the coil of pipe r, immersed in a tank s, containing methylated alcohol or pure alcohol, the tank being made, preferably, with double walls o and p and vacuum-jacketed, as above described. The carbon dioxid is allowed to expand in the coil of pipe down to about five or ten atmospheres, and in doing so the spirit in the tank s is cooled down to a very low temperature. In the tank are placed a number of covered metallic cylinders or boxes t or other suitable vessels with air-tight covers, and a part of the gas from the pipes is allowed to flow into these boxes by the valves x, where upon the expansion of a portion of the said liquefied gas the remainder is solidified. The unsolidified gas remaining in the pipe r after another portion has been admitted to the tanks and become solid is returned to the compressor through the pipe w, which in this case is connected to the pipe i, and the gas is thus sent back for recompression, as described for the foregoing process. When the boxes t have collected a sufficient amount of solid carbon dioxid, they are removed from the spirit-tank, and the pipes x being uncoupled the boxes t are allowed to stand in the air for a few minutes and then opened and the block of ice taken out, which can be readily done, as the walls of the box have become slightly warmed by standing in the air. The boxes are also made slightly tapering for the purpose of facilitating the removal of the ice blocks.

Instead of cooling the spirit in the tank with carbon dioxide any other cooling medium may be used, such, for instance, as air, ammonia, ether, or the so-called "Pictet" fluid, which consists of a mixture of carbon dioxid and sulfur dioxid, and in this case the carbon dioxid is simply compressed into the boxes immersed in the spirit-tank, and any waste is returned by a suitable arrangement of pipes to the compressor or the gas-holder. Any two or more substances may be used for cooling the gas, or it may be partially cooled by its own expansion and further cooled by the action of the other substances.

The solid carbon dioxid, either in the form of snow or broken ice, is compressed into any of the following forms for convenience of manipulation, and thus rendered available for nearly all purposes for which ice is now used, as well as for many other purposes, among which is the manu-

facture of aerated waters or other beverages without machines of any kind.

The solidified dioxid is compressed by an ordinary press into the form of blocks or slabs, and these blocks or slabs are scored or divided in such a way as to facilitate their being broken up into squares or cubes or tablets or other forms of suitable weight, and their weight and the quantity of gas they will produce at atmospheric pressure is impressed on each block, either at the time of compression or at a subsequent operation. In this way a known weight or volume may be readily broken off and sold or used in an ordinary ice-box. This form of the solid is also useful for providing the gas in the present type of aerating-machines, as any desired quantity can at once be placed in the gas-holder of such a machine, where on volatilization it will be ready for use in the ordinary way.

Instead of compressing it into the form of large slabs or blocks the solidified dioxid may be compressed into thin sheets or slabs, and these slabs may be so constructed that they may be readily broken into sticks, rods, tablets, or other small pieces. For the manufacture of aerated beverages without a machine these pieces are of such a size as to give off the proper quantity of gas to aerate the water in any given bottle. Each of the pieces is stamped with the weight or volumes of gas of which it consists and also the size of the bottle which it will aerate. By simply dropping one of these pieces into a bottle of water and shaking it by hand or by any convenient way the water will almost immediately become impregnated with the gas. In this way the aerating-machine with all its complications is completely done away with. By the use in this way of solidified gas all danger from bursting storage vessels is done away with and also the large amount of freight now paid for the transportation of these vessels, the weight of which is from two and one-half to three times the weight of the liquefied gas with which they are charged. The solidified gas can be carried in simple felt bags or bags of other non-conducting material. It can also be stored or transported in an ordinary ice-box.

[fol. 461] By the improved means of preparing and transporting solidified carbon dioxide this material will be ren-

dered available for all or nearly all purposes for which ice is now used, as well as for any other purposes for which ice is unsuitable. By placing a small quantity of solidified gas in a small box, preferably made of silver or aluminum, and which box may also contain ether or alcohol, and immersing the box in any liquid or solution the latter may be cooled without contact with the gas, and in this way the delicate bouquet of wines and other liquors is preserved.

What I claim as my invention, and desire to secure by Letters Patent of the United States, is—

The apparatus for solidifying carbon dioxide which consists of a compressor having a series of cylinders arranged for serial compression, a regenerative refrigerator with a pipe connecting the same with the last of the series of compression-cylinders, an expansion-engine operating a compression-cylinder and having its expansion-cylinder connected by a pipe with said regenerative refrigerator, an enlarged funnel-shaped vacuum-jacketed chamber conneeted with the exhaust from the expansion-cylinder of said engine, a baffle-plate extending across the upper portion of said chamber, an opening for the solidified gas in the bottom of said chamber, a compressor communicating with the opening in the bottom of said chamber for pressing the said solid carbon dioxide, a pipe connecting the top of said chamber above said baffle-plate with the said regenerative refrigerator, said refrigerator connected to the compression-cylinder of said expansion-engine, and the exhaust from said cylinder connected with one of the cylinders of the said serial compressor, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

Herbert Samuel Elworthy.

Witnesses: Edwin R. Smetham, Hormuspie Jamaspie.

(Here follow photostats of side folios 462, 463, and 464)

DEFENDANT'S EXHIBIT H 4

OFFICE NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE.

BREVET D'INVENTION

au 17 juin 1903.

XV. — Éclairage, chauffage et réfrigération.

4. — Réfrigération.

N° 333.181

Brevet de quinze ans demandé le 17 juin 1903 par **M. Henri-Félix-Jules CREPIN** résidant en France.

Dispositif pour la conservation des matières alimentaires et autres au moyen du froid produit par l'acide carbonique.

Délivré le 14 septembre 1903; publié le 17 novembre 1903.

L'invention qui fait l'objet de la présente demande de brevet est relative à un dispositif pour l'emploi de l'acide carbonique liquide, à la production du froid dans les meubles glacières pour la conservation des denrées alimentaires.

On se sert actuellement de glace que l'on met dans un récipient *ad hoc* situé dans le haut de la glacière; au contact, l'air se refroidit et, en raison de sa densité, tombe dans les parties inférieures en chassant l'air plus chaud qui lui-même vient se refroidir au réservoir à glace. Les inconvénients de ce moyen sont l'impossibilité d'obtenir de très basses températures, et la présence de vapeurs d'eau qui entretiennent presque constamment de l'humidité dans la glacière.

Le dispositif que j'ai imaginé permet d'utiliser l'acide carbonique à deux fins :

1° En utilisant le passage de l'état liquide à l'état gazeux pour la production du froid nécessaire à entretenir une basse température dans la glacière, et sans humidité, l'acide carbonique liquide employé étant anhydre.

2° En utilisant les propriétés antiseptiques de l'acide carbonique qui remplace complètement l'air dans la glacière, de telle sorte que les produits alimentaires à conserver se trouvent constamment dans une atmosphère d'acide carbonique impropre aux fermentations et restent à l'abri de l'air.

Le dispositif est plus particulièrement caractérisé par un réservoir de détente, placé entre le récipient à acide carbonique liquide et le conduit par lequel l'acide carbonique s'échappe sous la forme gazeuse dans la caisse renfermant les matières à conserver.

Sur le dessin ci-joint, j'ai représenté à titre d'exemple respectif par les fig. 1 et 2 le schéma d'une installation d'ensemble et le détail d'une forme d'exécution d'un réservoir intermédiaire de détente.

a est une caisse de forme et de dimensions appropriées. Le tube à acide carbonique *b* se trouve placé soit dans l'intérieur de cette caisse, soit au-dessus ou à côté, mais toujours de façon que la tête se trouve en bas, ce qui permet au liquide quand on ouvre le robinet *c* de se rendre directement dans le réservoir de détente *d* d'où il s'échappe et pénètre dans un serpentin radiateur *s*. L'acide carbonique pénètre dans le réservoir *d* par le tuyau *e* prolongé et vient frapper la paroi inférieure *f* de la boîte *d* où il forme un dépôt neigeux. L'acide carbonique s'évapore et s'élève entre les chicanes *g*, puis s'échappe par les orifices *h* du tuyau axial *i* qui se termine à l'extrémité inférieure par un trou capillaire *n*; le gaz alors se détend dans le

serpentin à ailettes *s*, et est mis en liberté dans la glacière. En raison de son poids, l'acide carbonique tombe au fond et chasse l'air par les trous *o* qui se trouvent dans le haut de la glacière.

La détente du gaz provoque dans les serpentins radiateurs et dans la boîte *d* de l'acide carbonique solide ou en neige. Cette neige ayant une température de — 78° refroidit suffisamment l'atmosphère intérieure de la glacière.

Les détails de construction et de montage des divers éléments du dispositif peuvent varier sans altérer le principe de l'invention. C'est ainsi que le ou les tubes *b* au lieu d'être disposés verticalement pourraient être inclinés; le récipient *d* au lieu d'être séparé de la caisse *a* pourra être venu de fonte avec celle-ci. Le serpentin à ailettes pourra être placé et fixé en un point convenable quelconque de l'appareil.

L'invention et ses caractéristiques essentielles peuvent en somme se synthétiser comme suit :

a) Un appareil ou dispositif pour la production du froid destiné plus particulièrement à la conservation des denrées, constitué par une caisse *a* dans, auprès de ou sur laquelle sont disposées une ou plusieurs bouteilles *b* à acide carbonique liquéfié ou comprimé, avec leur orifice de vidange placé à la partie inférieure, lesdites bouteilles étant reliées à un réservoir de détente *d* pour la production d'acide carbonique solide, relié lui-même à un serpentin de détente *s* par lequel le gaz acide carbonique s'échappe dans la caisse *a* en chassant l'air qui est évacué à travers des orifices placés dans la partie haute de ladite caisse *a*.

b) Une forme d'exécution du réservoir de détente intermédiaire caractérisée par un conduit *e* de raccordement avec les bouteilles à acide carbonique, plongeant au fond du réservoir de façon que le liquide qui s'échappe vienne frapper la paroi de l'enveloppe, ledit réservoir étant en outre pourvu de chicanes *g* et d'un tube central d'évacuation percé d'orifices *h* à la partie supérieure et d'un trou capillaire *m* à la partie inférieure où il débouche dans le serpentin *s*.

Par procuration
de : Henri-Félix-Jules Cazeau.

Emile Bizet.

N° 333.181 M. Crepin Pl. unique

Fig. 1.

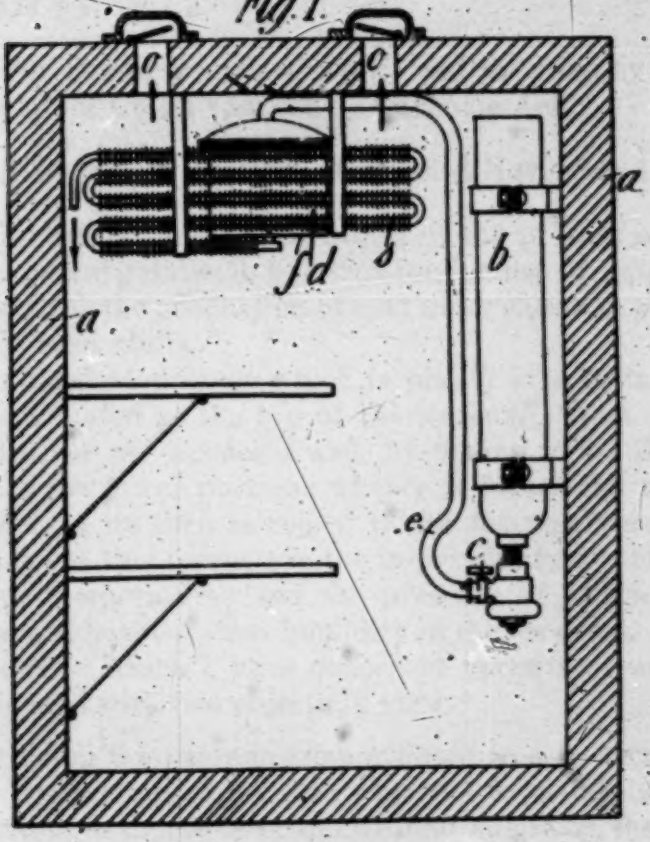
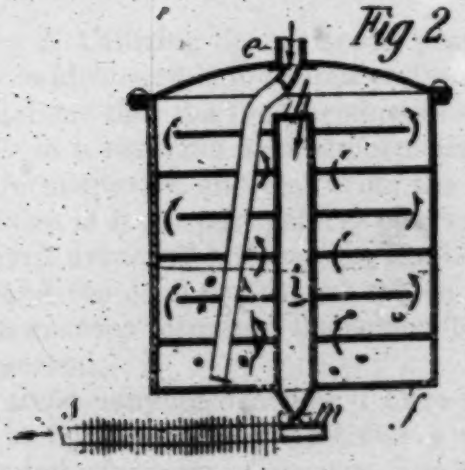


Fig. 2.



[fol. 465] Translation of French Patent #333,181, of June 17, 1903. Issued to Mr. Henri-Felix-Jules Crepin, a Resident of France

Device for Preserving Food Stuffs and the Like by Means of Cold Produced by Carbonic Acid

Granted September 14, 1903. Published November 17, 1903

The invention forming the object of the present application for patent relates to a device for the use of liquid carbonic acid for the production of cold in ice chests in order to conserve food stuffs.

Ice is used at present which is placed in a suitable receptacle situated at the top of the ice box. Upon contact therewith the air is cooled and, by reason of its density, falls into the lower portions whence it forces the warmer air, which in its turn is cooled in the ice reservoir. The drawbacks of this means are the impossibility of obtaining very low temperatures and the presence of steam which maintains almost constant humidity in the ice chest.

The device which I have conceived permits of utilizing carbonic acid with two objects in view.

1. Utilizing the passage from a liquid to a gaseous state for the production of the cold required to maintain a low temperature in the ice box; and without humidity, the liquid carbonic acid used being anhydrous.

[fol. 466] 2. Utilizing the antiseptic properties of the carbonic acid which completely replaces the air in the ice box, in such manner that the food products to be preserved are constantly in a carbonic acid atmosphere which is unsuitable for fermentation and free from the effects of the air.

The device is more particularly characterized by an expansion tank arranged between the liquid carbonic acid receptacle and the conduit through which the carbonic acid escapes in gaseous form into the box containing the articles to be preserved.

In the accompanying drawing, I have represented as an example in fig. 1 and 2, respectively a whole installation and the detail of a form of construction of an intermediate expansion tank.

a is a chest of suitable shape and size. The carbonic acid tube b is placed either in the interior of said chest, or above or at the side but always so that the head is down which permits the liquid, when the valve c is opened, to pass directly into the expansion tank d, whence it escapes and enters into a radiating coil s. The carbonic acid penetrates into the tank d through the extension tube e and strikes against the lower wall f of the chest d where it forms a snowy deposit. The carbonic acid evaporates and rises between the baffles g, then escapes through the openings h in the axial tube i which ends at the lower part in a capillary hole m. The gas then expands in the flanged coil s and is liberated in the ice box. [fol. 467] By reason of its weight, the carbonic acid falls to the bottom and forces the air out through the holes o provided in the upper part of the ice box.

The expansion of the gas produces in the radiating coils and in the box d, carbonic acid, either solid or in snowy form. This snow, having a temperature of —78°, freezes the air in the interior of the box sufficiently.

The details of construction and installation of the various parts of the device may vary without altering the principle of the invention. Thus the tube or tubes b may be inclined instead of being arranged vertically; the tank d, instead of being separated from the box a, may be integral therewith. The flanged coil may be placed and secured at any convenient point of the apparatus.

The invention and its particularly characteristic features may be summarized as follows:

a) An apparatus or device for the production of cold intended more particularly for the preservation of food stuffs comprising a chest a, in which, near which, or upon which, are arranged one or more bottles b of carbonic acid, either liquified or compressed with their outlet opening placed at the lower part, said bottles being connected with an expansion tank a for the production of solid carbonic acid, said tank being connected with an expansion coil s, through which the carbonic acid gas escapes into the box a forcing therefrom the air through the openings arranged in the upper part of said box a.

[fol. 468] b) A form of construction of the intermediate expansion tank, characterized by a conduit e connected with

DEFENDANT'S EXHIBIT H 5 469

RÉPUBLIQUE FRANÇAISE.

OFFICE NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE.

BREVET D'INVENTION.

XIV.—Arts chimiques.

1. — Produits chimiques.

N° 344.957

Procédé d'emmagasinage et de transport de l'acide carbonique à l'état solide et à basse température.

Société dite : Gebr. HEYL & Cie, Gesellschaft mit beschränkter Haftung. et M. Adolf WILTZE résidant en Allemagne.

Demandé le 19 juillet 1904.

Délivré le 13 septembre 1904. — Publié le 18 novembre 1904.

Comme on le sait, le point d'ébullition de l'acide carbonique liquide est 79°C.; une pression de 3,5 atmosphères seulement suffit, lorsqu'il est à son point d'ébullition, pour le liquéfier à nouveau.

A l'évaporation, l'acide carbonique liquide comme on le sait aussi, se solidifie en une masse neigeuse et peut sans grande difficulté, pourvu qu'on ait soin de maintenir une température suffisamment basse, être retenu sous cette forme pour son transport.

L'invention consiste à utiliser ces propriétés de l'acide carbonique, c'est-à-dire à l'emmagasiner et à l'expédier à l'état solide sous la pression ordinaire et en maintenant seulement la température suffisamment basse. Ce procédé présente sur le mode d'emmagasinage ordinairement employé jusqu'ici pour l'acide carbonique un avantage particulier : c'est que, au lieu de faire usage, pour le transport, de cylindres en acier capables de résister à une pression de 250 atmosphères environ, on peut, pour l'emmagasinage ou le transport, se servir simplement de récipients hermétiquement clos maintenus à la basse température voulue.

La fig. 1 des dessins ci-annexés représente un récipient de forme convenable qui peut être clos au moyen de bouchons d et d^1 faisant joint étanche et d'étriers de fermeture f et f^1. Ce récipient est muni d'une double enveloppe comportant un espace vide b et une couche extérieure c mauvaise conductrice de la chaleur, garnie à son tour d'une manière isolante.

Dans l'espace vide b se trouve toujours un mélange réfrigérant, de préférence, par de l'acide carbonique liquide et de l'éther. L'évaporation de ce mélange réfrigérant placé dans l'espace b assure le refroidissement constant du contenu de la chambre a où se trouve l'acide carbonique à l'état solide. g et g^1 désignent des soupapes de sûreté.

Dans la chambre d'évaporation b est agencé un petit appareil d'aspiration et de compression dont la tige de piston, actionnée de l'extérieur par une commande quelconque s, traverse une boîte de garniture p assurant l'étanchéité. Cet appareil de compression aspire continuellement en l, au moyen du tube k, les vapeurs se dégageant du mélange d'éther et d'acide carbonique, les comprime et les renvoie à l'état liquide, par la tuyère m, dans la chambre d'évaporation. Une force motrice très faible suffit pour opérer la régénération constante du réfrigérant, ainsi que le refroidissement continuel de la chambre a et, par conséquent, pour assurer l'emmagasinage sans perte de l'acide carbonique contenu dans cette dernière chambre. Un piston de pompe foulante, indiqué schématiquement sur le dessin par le

système de tiges *c-n*, sert à évacuer par une tubulure, formée à la chambre *a*, la quantité d'acide carbonique solide désirée. On peut l'envoyer à l'état solide, en le refoulant à l'aide de ce piston, par exemple dans des cylindres en acier (fig. 2) capables de résister à la pression. Les cylindres en acier, eux-mêmes, présentent sur le fond, par exemple, une plaque de fermeture ovale susceptible de tourner et qui assure l'herméticité sous l'influence de la pression de l'acide carbonique régnant à l'intérieur (fig. 3). Lors du remplissage, ces cylindres sont également pourvus d'une double enveloppe, à savoir : d'une enveloppe extérieure *b* mauvaise conductrice de la chaleur, avec un espace vide *g* rempli d'un mélange réfrigérant. Ici aussi, les vapeurs qui se dégagent du mélange réfrigérant sont reprises en *g* par un tube *f*, et un petit compresseur *e*, *d* les renvoie à l'état liquide, par la tuyère *h*, dans la chambre d'évaporation.

Le mode d'emploi des cylindres ainsi garnis est exactement le même que celui des cylindres en acier remplis d'acide carbonique liquide qu'on trouve dans le commerce. La fig. 3 représente le fond du cylindre; *o* désigne le couvercle ovale, *p* l'étrier de fermeture et *q* la vis de fermeture.

On connaît déjà le procédé consistant à emmagasiner des gaz condensés en vue de leur utilisation, voir par exemple la patente anglaise n° 21861 de 1899; mais jusqu'ici ce procédé n'a pas été appliqué à l'emmagasinage et au transport de l'acide carbonique condensé.

résumé.

L'invention porte essentiellement sur un procédé d'emmagasinage et de transport de l'acide carbonique à l'état solide, sans pression, mais à basse température, qui consiste à introduire l'acide carbonique à l'état solide dans des récipients où une basse température, inférieure au point d'ébullition de l'acide carbonique, est maintenue d'une façon constante à l'aide d'un mélange réfrigérant; ce mélange étant, de préférence, constamment régénéré par l'aspiration et la condensation des vapeurs au moyen d'un compresseur logé dans la chambre d'évaporation. L'invention comprend aussi le transvasement d'acide carbonique solide dans des cylindres robustes propres à son transport, sans pression et avec application d'un refroidissement énergique.

Société dite : GEBR. HEYL & C°,
Gesellschaft mit beschränkter Haftung,
par A. WULTZE.
Par procuration :
Charles Aser.

471=472

N° 344.957 Société dite : Pl. unique

Gebr. Heyl & C° Gesellschaft mit beschränkter Haftung

& M. Wultze

Fig. 1.

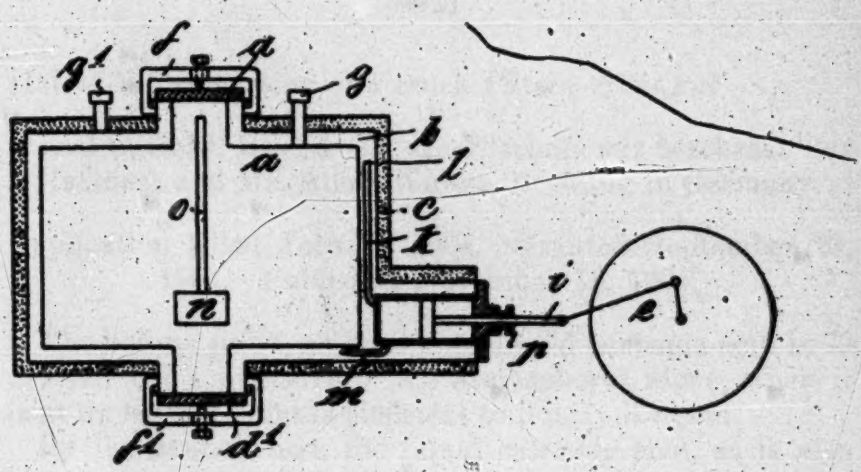


Fig. 2.

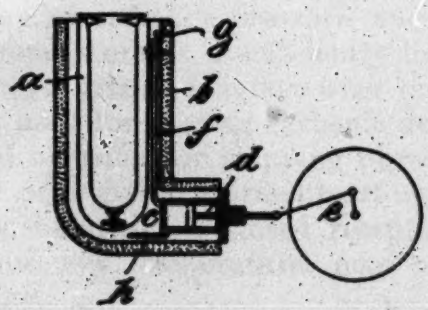


Fig. 3.

the carbonic acid bottles and extending to the bottom of the tank in such manner that the escaping liquid strikes the wall of the envelope; said tank being furthermore provided with baffles g and a central evacuation tube provided with orifices h at the upper part and with a capillary hole m at the lower part where it opens into the coil s.

(Here follow photostats of side folios 469, 470, and 471 & 472)

[fol. 473] Translation of French Patent #344,957

Issued to Gebr. Heyl & Co., Gesellschaft mit beschraenkter Haftung, and Mr. Adolf Wultze, Residing in Germany.

Application Filed July 19, 1904. Granted September 23, 1904. Published November 18, 1904.

The boiling point, as known, of liquid carbonic acid is 79 degrees C.; a pressure of 3.5 atmospheres alone, when it is at its boiling point is sufficient to liquify it again.

By the evaporation, the liquid carbonic acid, as is also known, is solidified into a snowy mass and can be maintained in this form for shipping, without great difficulty, provided care be taken to maintain a sufficiently low temperature.

The invention consists in utilizing these properties of the carbonic acid; that is, storing and shipping it in solid state under ordinary pressure, and by simply maintaining the temperature at a sufficiently low point. This process presents a great advantage over the method hitherto ordinarily used for storing carbonic acid; that is to say, that instead of using for shipping purposes steel cylinders capabale of resisting a pressure of approximately 250 atmospheres, hermetically closed receptacles maintained at the requisite low temperature, may be used for storing or shipping.

Fig. 1 of the accompanying drawings shows a receptacle [fol. 474] of suitable form, which may be closed by means of stoppers d and d^1 forming a tight joint and closing straps f and f^1. This receptacle is provided with a double envelope comprising a vacuous space b, and an outer layer c

which is a poor conductor of heat, and which in its turn is lined in an insulating manner.

The vacuous space b contains always a refrigerating mixture, preferably of liquid carbonic acid and ether. The evaporation of this refrigerating mixture placed in the space b insures constant cooling of the contents of the chamber a, where the carbonic acid in solid state is located g and g^1 designate safety valves.

In the evaporation chamber b is provided a small suction and compression apparatus, the piston rod of which, operated from the exterior by any suitable control e, passes through a stuffing box p, which insures tightness. Said compression apparatus sucks continuously at l, through the tube k, the vapors rising from the mixture of ether and carbonic acid, compresses them and returns them to a liquid state through the tube m in the evaporation chamber. A very slight motive power is sufficient to produce the constant regeneration of the refrigerant, as well as the continual cooling of the chamber a, and thus insures storing without loss of the carbonic acid contained in the last-named chamber. A forcing-pump piston, shown in the drawing by the rod o-n, is used for the evacuation, through a pipe arranged in the chamber a, of the desired quantity of solid carbonic acid. It may be turned into a solid state by forcing it back by means of said piston, for example, into two steel cylinders (Fig. 2) capable of resisting the pres- [fol. 475] sure. The steel cylinders themselves have at the bottom, for example, an oval closing plate adapted to turn and which insures hermetical closure under the pressure of the carbonic acid in the interior, (Fig. 3). At the time of filling, these cylinders are also provided with a double envelope, that is to say, an outer envelope b being a poor conductor of heat, with a vacuous space g filled with a refrigerating mixture. In this case also, the vapors rising from the refrigerating mixture are collected at g through a tube f, and a small compresser c, d, returns them to a liquid state through the tube h in the evaporation chamber.

The method of using cylinders thus provided is exactly the same as that of steel cylinders filled with liquid carbonic acid and which are usually found in commerce. Fig. 3 represents the bottom of the cylinder; o designates the oval cover, p the closing strap, and q the closing screw.

The process consisting in storing condensed gases for purposes of utilizing them, is known, for example, through the English patent #21861 of 1899, but so far this process has not been used for storing and shipping of condensed carbonic acid.

Résumé

The invention relates mainly to a method of storing and shipping carbonic acid in solid state, without pressure, but at low temperature, which consists in introducing carbonic [fol. 476] acid in solid state into receptacles where a low temperature, lower than the boiling point of carbonic acid, is maintained in a constant manner by means of a refrigerating mixture; said mixture being preferably constantly regenerated by the suction and condensation of the vapours by means of a compressor located in the evaporation chamber. The invention comprises also the transfer of solid carbonic acid into strong cylinders suitable for shipping, without pressure, and by applying powerful cooling.

[fol. 477] DEFENDANT'S EXHIBIT H 6

N° 2450 **A.D. 1906**

(Under International Convention)

Date claimed for Patent under Patents Act, 1901, being date of first Foreign Application (in France), 31st Jan., 1905

Date of Application (in the United Kingdom), 31st Jan., 1906

Under Section 1 (2) of the Patents Act, 1901, this Specification became open to public inspection at the expiration of twelve months from the date of the application in France

Accepted, 26th July, 1906

Complete Specification

Improvements in Processes for Solidifying Carbonic Acid and Apparatus Therefor

I, Ellen Gertrude Elworthy, Widow and Administratrix of the late Herbert Samuel Elworthy, Chemical Engineer, of Battlefield Road, St. Albans, England, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention has reference to improvements in processes for solidifying carbonic acid and apparatus therefor and, more particularly to improvements in the process and apparatus described in my prior Specification No. 7436 of 1895.

Carbonic acid chemically known as carbon di-oxide may be manufactured by any well known process, or obtained from any source, but if manufactured I prefer to use the process as patented by me in English Patent No. 25007 of 1897, but the waste carbonic acid from fermentation when properly purified, or the waste gas from the manufacture of yeast, or the natural carbonic acid obtained from many natural springs or wells may with advantage be used in many cases.

Whether the carbon di-oxide be obtained as waste carbonic acid from fermentation or as waste gas from the manufacture of yeast, its recuperation if not operated with a view to solidifying it, is not practical as the use of liquid carbonic acid is only a very restricted one and needs very expensive devices for storing it up and for transporting it (by means of thick walled closed tubes) which may be avoided by solidification.

The carbon di-oxide however obtained is passed under any suitable pressure, either atmospheric or higher pressure, through a pipe or pipes being either coiled, straight, or arranged in any other suitable form, and such pipe or pipes may be either enclosed in and concentric with larger pipes, or it or they may be enclosed in a chamber, and such outer pipe or pipes or chamber is insulated in any known

[fol. 478] manner to prevent the inward radiation of heat from the surrounding air.

Through the above described outer pipe or pipes or chamber, cold air or other gas is circulated, such air or gas being cooled to nearly the solidifying point of carbon di-oxide, and below its liquefying point at the pressure used.

If preferred instead of the cold air, highly cooled brine, spirit, or other liquid may be used, as in the manufacture of artificial ice, but preferably at a much lower temperature.

The carbon di-oxide having liquefied in the manner above described, the liquid is drawn off into moulds or receptacles, preferably of copper, aluminium or other good heat conducting material, and such moulds or receptacles are enclosed in an insulating tank or box which may be either filled or partly filled with a liquid whose solidifying point is below that of the carbon di-oxide such as alcohol, and this liquid is cooled to the desired degree by the circulation of cold air or other gas through coils of pipe immersed therein. Instead of the liquid cooling medium, the moulds may be cooled by circulating the cold air or gas round and directly in contact with them.

If it is preferred the carbon di-oxide may be liquefied by compression in the ordinary manner by means of suitable pumps, as now carried on commercially, and the liquefied gas from the compressor may be cooled to the required extent by passing it through pipes externally cooled, either by means of cold air or other gas, or by means of the evaporation of part of such liquefied gas itself in the ordinary well known or so called "self-intensive" manner, a suitable bye pass being provided for the purpose.

Having obtained the liquid cooled as above, it is then drawn off into the moulds above described where in it is solidified.

The moulds may be of any required form, but are preferably made with a slight taper, being slightly wider at the top, so as to allow of easy extraction of the solid.

In order to reduce the temperature of the air or gas to a sufficient degree to solidify the carbon di-oxide it may, after compression and cooling by water in the ordinary commercial way, be expanded in the now well known "self intensive" manner, whereby a part of the compressed air is cooled to a very great degree, by the expansion of another

part thereof, and to still further increase the efficiency of the cooling, the compressed air before expansion, or any part thereof, may be caused to do work in a motor, and the cold air discharged from such motor may then be caused to circulate round the pipe containing the compressed air, thereby still further cooling the latter. The cooling may also be effected by a combination of these methods.

The air cooled by any of the above described methods, is then allowed to flow into coils immersed in strong alcohol or methylated spirit, in which the moulds for the solidified carbon di-oxide are placed.

An alternative and equivalent method of working is as follows. Carbonic acid, however made, is liquefied in the usual way, and flows through a tube which is contained in another and large tube. A small amount of the liquefied gas is allowed to flow through a bye-pass and jet into the outer tube, whereby the liquid in the inner tube is cooled down to below its boiling point at atmospheric pressure, and it is then run off into moulds which are immersed in the cold spirit, where it becomes solidified.

Instead of using cold air and alcohol, the moulds may be immersed in a box or chamber, which may be filled with carbon di-oxide "snow," or with a mixture of such snow with ether, the carbonic acid generated from the snow, is then carried back to the compressor, and as it is at an intensely low temperature—say minus 79 degree- Centigrade, it would be used for cooling the liquefied gas, before it is admitted into the moulds for solidification.

The moulds may be made with double walls, in such a [fol. 479] way that the interior of the mould may be connected with the liquefying coil from the compressor, whilst the space between the walls is connected to the same coil by means of a bye-pass, and a certain amount of the liquid may be allowed to expand in such space, thus cooling the liquid in the interior to the solidifying point, and the gas which escapes after expansion may be carried back to the inlet of the compressor. If preferred the cold air obtained in the manner herein-before described, or liquefied air or liquefied ethylene or other gas may be passed into the space between the walls of the moulds, and be used for solidifying the liquefied gas with which the moulds are filled. In order

to assist this action, these moulds may also be immersed in highly cooled alcohol as above described.

Liquefied air or liquefied ethylene or other gas may also be used in the insulated chamber containing the moulds such liquefied air being either passed directly into the insulated chamber to cool the moulds or it may be passed through the cooling coils herein before described and used for the purpose of cooling the alcohol or other liquid in which the moulds are immersed.

In the annexed drawings given by way of example:

Fig. 1 shows diagrammatically a plant for carrying out the above described process whilst Fig. 2 shows a modified form of the mould cooling tank.

The carbonic acid from any source is liquefied by pressure in the ordinary manner in the gas compressor A from whence it passes to the water-cooled coil B, and thence into the "self-intensifying" cooling coil C, and passing through the inner tube D of said coil, part of it is allowed to escape through a bye-pass E, back into the outer pipe F of the said coil where it flows in a contrary direction to the current in D, and finally passes back to the compressor A through the pipe G and valve H, connecting the pipe G to the inlet tube I of the said compressor.

The remainder of the liquefied carbonic acid in the tube D, now cooled to such an extent that its vapour pressure is about that of the atmosphere, passes through the tube J and valves K and L into the interior of the double-walled mould M, until the latter is full, or nearly so, when it is ready for solidification.

In order to solidify the carbonic acid in the moulds M, liquefied ethylene (or other gas or air) passes from the compressor N into the water cooled tube O, and thence into the inner tube P of a counter-current system. From the tube P, the gas is passed into the space Q between the double walls of the mould M, through the pipe R and valves S and T, where, expanding back to the gaseous form, and having absorbed heat from the carbonic acid in the mould M, it passes away by the tube U and valves V and W to the outer tube X of the system, and thence back by the pipe Y to the inlet of the compressor N. This compressed or liquefied gas or air works therefore in a closed system.

Where it is preferred to cool the mould by means of a liquid having a sufficiently low freezing point, such as alcohol, the insulated tank or box A^1 is arranged with a coil of pipe round its interior sides, said pipe C^1 being connected at one end to the tube P (Fig. 1) and at the other end to the tube Y (Fig. 1), whereby a current of the liquefied ethylene (or other gas or air) is circulated through it. The tank is partially filled with the alcohol or other suitable fluid B^1 and the moulds M^1, which in this case are made with a single wall, are immersed therein. These moulds M^1 are connected by means of the tube J^1 and the valves K^1 to the tube J (Fig. 1), whereby they become filled with the liquefied carbonic acid ready for solidification.

When the carbonic acid has become solidified either as in Fig. 1 or Fig. 2, the mould or moulds is or are disconnected and either slightly warmed, or allowed to stand in the air for a short time, whereby the solidified carbonic acid partly melts round the walls of the mould and is then easily removed and stored in a suitable chamber.

[fol. 480] Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A method of solidifying carbonic acid in moulds with double walls, by means of the expansion of part of such carbonic acid whilst in the liquefied state, such expansion taking place in two stages, the first expansion taking place in the outer coil of two concentric coils whereby the remainder of the liquid in the inner coil is partly cooled and the second by the expansion of another portion of the liquefied gas in the space between the double walls of the moulds, whereby the remaining portion of the liquefied gas which has passed into the interior of such moulds is solidified by the cold produced by such expansion.

2. A method of solidifying carbonic acid whereby the carbonic acid to be solidified is passed, either in the gaseous or liquid state through an inner coil concentrically arranged within an outer and larger coil, in which highly cooled air or gas is caused to circulate in a direction contrary to the flow of the carbonic acid in the inner coil, and then passing such cooled carbonic acid into double walled moulds and finally cooling the liquefied carbonic acid contained in the

A.D. 1906 Jan. 31. N° 2450.
ELWORTHY'S Complete Specification.

[This Drawing is a reproduction of the Original.]

Fig. 1.

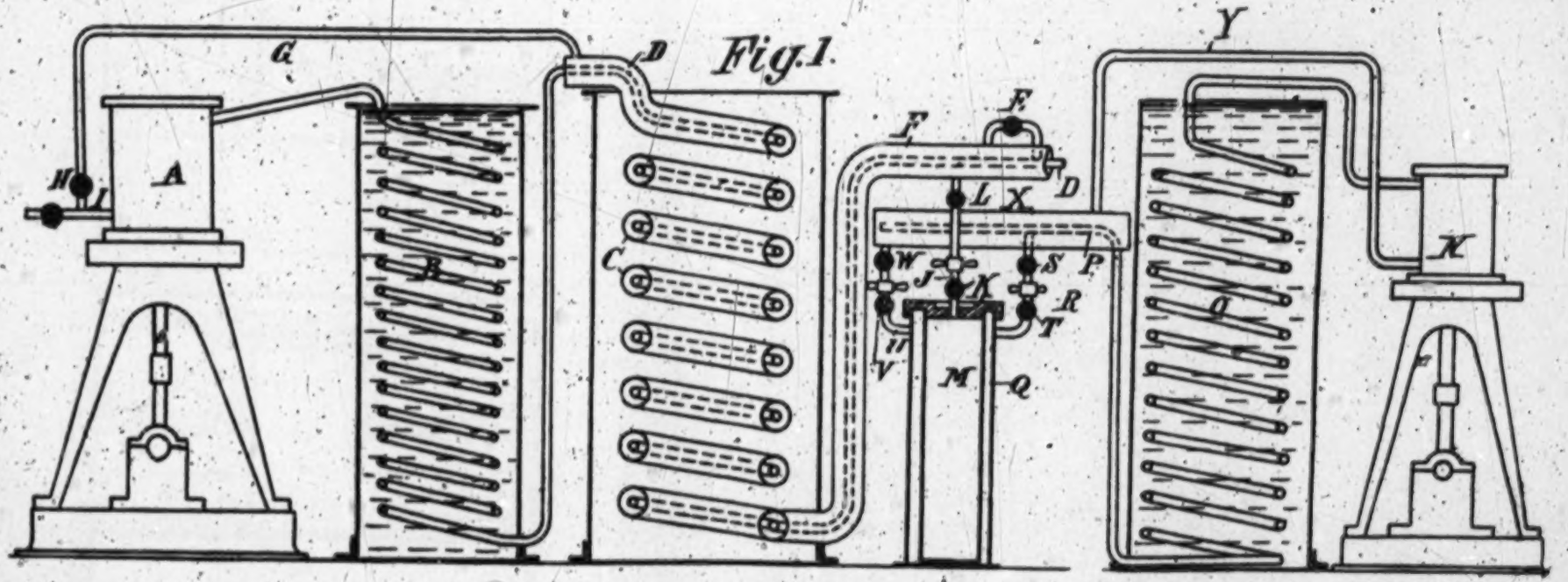
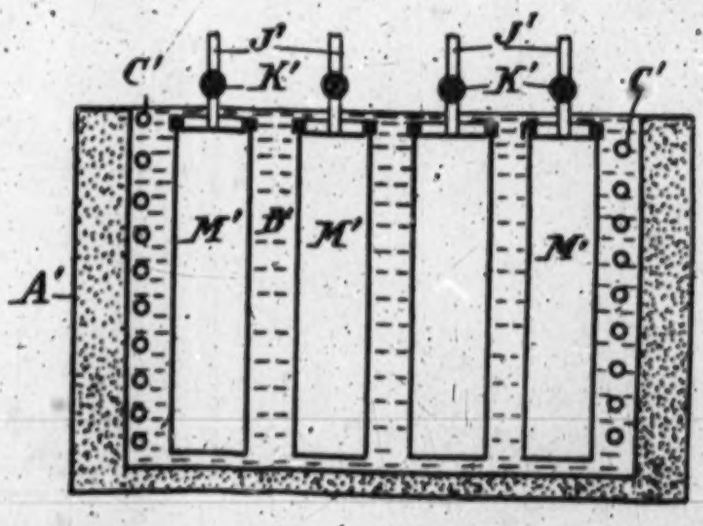


Fig. 2.



DEFENDANT'S EXHIBIT H 7

482
(No Model.)

J. MOSLER & H. LADEWIG.

Refrigerating Butter Box.

No. 236,906. Patented Jan. 25, 1881.

Fig. 1.

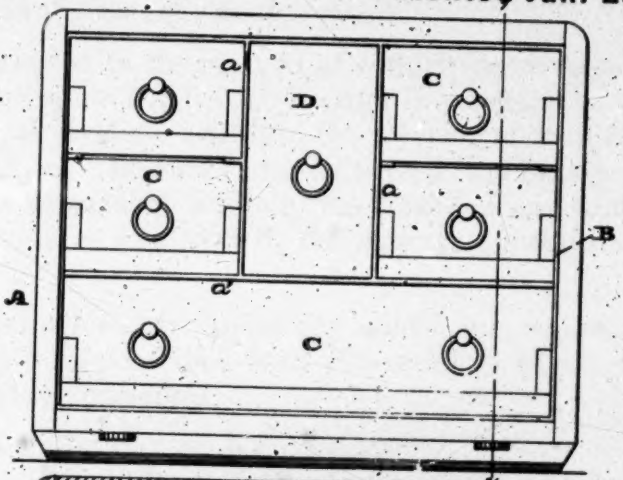


Fig. 2.

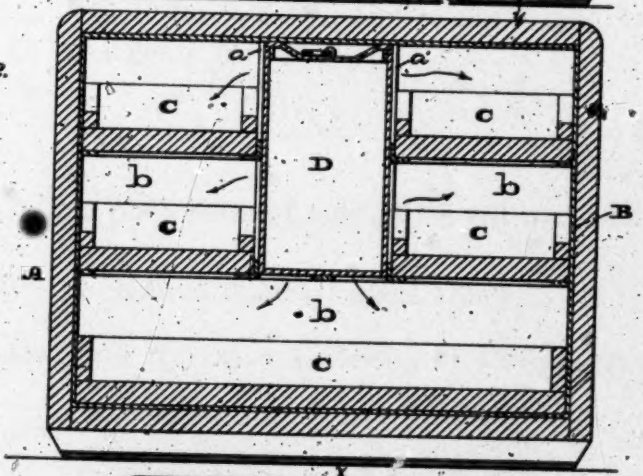
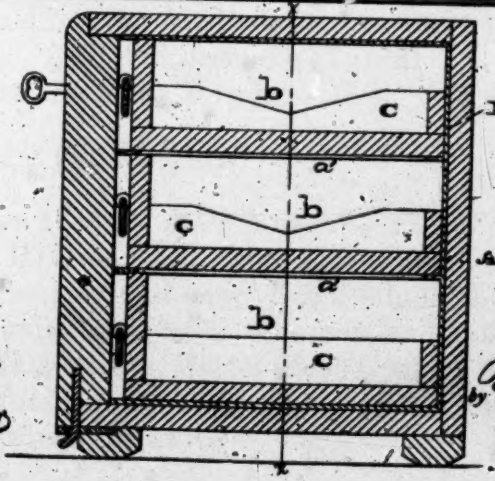


Fig. 3.



Witnesses:
A. P. Grant,
H. J. Kircher

Inventors:
John Mosler,
Herman Ladewig
by John A. Dieterich
ATTORNEY.

interior of the moulds by passing highly cooled air or other gas into the space between the walls of such moulds, substantially in the manner as described.

3. A variation in the method of solidifying carbonic acid claimed in Claims 1 and 2, consisting in passing the cooled and liquefied carbonic acid into the interior of moulds with single walls, said moulds being immersed in a highly cooled liquid such as alcohol whereby the liquefied gas contained in the moulds is solidified in the manner substantially as described.

4. The improved apparatus for solidifying carbonic acid substantially as described with reference to Fig. 1 of the accompanying drawings.

Dated this 31st day of January, 1906.

Chas. Bauer, Imrie & Co., 72 Cannon Street, London, E. C., Agents for the Applicant.

(Here follow photostats of side folios 481 and 482.)

[fol. 483] United States Patent Office

John Mosler and Herrman Ladewig, of Philadelphia, Pa.

Refrigerating Butter-box

Specification Forming Part of Letters Patent No. 236,906, Dated January 25, 1881.
Application Filed March 24, 1880. (No model.)

To all whom it may concern:

Be it known that we, John Mosler, a citizen of the United States, and Herrman Ladewig, a subject of Prussia, both residing in the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Refrigerating Butter-Boxes, which improvement is fully set forth in the following specification and accompanying drawings, in which—

Figure 1 is a front view of the box embodying our invention. Fig. 2 is a vertical section thereof in line x x, Fig. 3. Fig. 3 is a vertical section in line y y, Fig. 1.

Similar letters of reference indicate corresponding parts in the several figures.

Our invention consists of a box inclosing a metallic frame having skeleton-shelving, on which are supported butter-drawers with open sides and an ice-chamber, whereby the butter placed in the drawers is subjected to cold air and kept in good and marketable condition.

Referring to the drawings, A represents a box, and B an inclosed frame, to which are secured uprights a and horizontal pieces a', or strips of metal connected or cast together, and forming a skeleton support or shelving for drawers C C and an ice-chamber, D. The sides of the drawers are cut away or set low, forming channels b, so that the air in the frame B, refrigerated by the ice in chamber D, has full access to the drawers, the skeleton support or shelving of the frame B also allowing free circulation of air throughout the frame.

Butter is placed in the drawers C and ice in the chamber D. The lid or door of the box A is closed, and the butter may then be sent to market or stowed away for use.

The cold air refrigerated by the ice in chamber D reaches every part of the same and passes through the channels b of the drawers to the butter, which is thereby kept cold and hard and in good condition.

When the butter is required the lid or door of the box is opened and the drawers pulled out, the butter thus being accessible.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In a refrigerator, a series of drawers, C, having channeled sides b, substantially as set forth.

2. The box A, in combination with the removable lining-frame B, having upright and horizontal pieces a a' connected to it, the ice-chamber D, and the drawers C, having

DEFENDANT'S EXHIBIT H 8

484

(No Model.).

T. DRUMMOND.

REFRIGERATOR SHIPPING BOX.

No. 533,794. Patented Feb. 5, 1895.

FIG. 1.

FIG. 2.

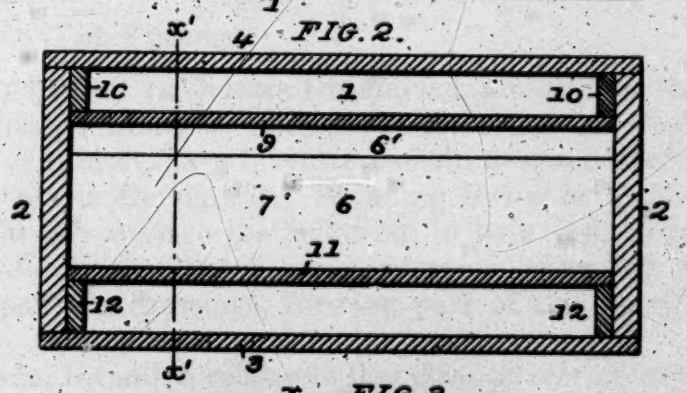
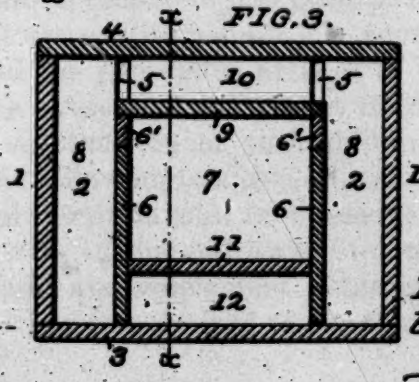



FIG. 3.



ATTEST:

Geo. H. Arthur

Wm. H. Holmes

INVENTOR:

Thos. Drummond,

by Robert Burns

Att'y.

channeled or cut-away sides b, substantially as and for the purpose set forth.

John Mosler, Herrman Ladewig.

Witnesses: John A. Weidersheim, W. F. Kircher.

(Here follows photostat of side folio 484.)

[fol. 485] United States Patent Office

Thomas Drummond, of Chicago, Illinois, Assignor to George T. Cook and W. W. Rathborne, of Same Place

Refrigerating Shipping-box

Specification Forming Part of Letters Patent No. 533,794, Dated February 5, 1895

Application filed February 10, 1893. Serial No. 461,795. (No model.)

To all whom it may concern:

Be it known that I, Thomas Drummond, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Refrigerator Shipping Boxes or Cases; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

The present invention relates to that class of refrigerator shipping boxes that are partitioned off into separate chambers for the ice and the perishable articles to be shipped.

The object of the present improvement is to provide a simple and cheap construction of such shipping cases or boxes embodying the following features, to-wit: an arrangement of the vertical partition wall in a removable manner within vertical grooves in the end walls of the box, so as to permit of a ready and convenient detachment of the interior partitions when it is desired to use the case or box

for ordinary shipping purposes, and which admits of the ready and convenient replacement of such interior partitions when it is desired to reconvert the box or case to its original use; a sectional formation of the vertical partition walls that form the inner receiving compartment, so as to permit of a ready change in the capacity of such inner compartment to suit the quantity of goods to be shipped; a false bottom arranged removably between the vertical partitions, so as to form a bottom compartment for the reception of ice and which is capable of being removed when it is desired to further increase the capacity of the shipping compartment; and cleats arranged between the main box cover and the inner compartment to hold the latter in place in a simple and effective manner during shipment. I attain such objects by the construction and arrangement of parts illustrated in the accompanying drawings, in which—

Figure 1, is a plan view of a case or box with the top covers removed, embodying the present improvements. Fig. 2, is a longitudinal section of the same at line x—x, Fig. 3 Fig. 3, is a transverse section at line x′—x′, Fig. 2.

Similar numerals of reference indicate like parts in the several views.

As represented in the drawings, the main outer box or case will be of the usual rectangular form and consist of vertical side walls 1, end walls 2, bottom 3, and cover 4, nailed or otherwise attached together in the usual manner.

In the present invention the end walls 2 will be provided with a pair of vertical grooves 5, located a suitable distance away from the side walls 1, and adapted to receive the vertical partitions 6, that extend the length of the case, and form the central receiving chamber 7 for the articles to be shipped, and the side chambers 8 for ice to preserve the same. These partitions 6 do not extend the full height of the interior of the box, but are curtailed, as shown, so as to leave a cross space above the cover 9 that fits on top of said partitions to cover and inclose the top of the receiving chamber 7. This cover 9 extends the full length of the box, and is held in place by the removable end cleats 10, inserted between said cover 9 and the main box cover 4, as shown in Fig 3. The partitions 6 are preferably made in sections, a main or lower section, and an upper or sup-

plementary section 6′, that is capable of ready removal when it is desired to decrease the capacity of the receiving chamber or compartment 7.

In my preferred construction as illustrated in the drawings, the bottom of the receiving chamber 7 is formed by a removable horizontal partition or bottom 11, supported a distance away from the main bottom 3 of the case or box, by end cleats 12 to form a lower ice receiving compartment beneath the receiving compartment 7, and which bottom is capable of ready removal when it is desired to increase the capacity of the receiving compartment 7.

Having thus fully described my said invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A refrigerator shipping box or case, comprising in [fol. 486] combination a box or case the end walls 2 of which are formed with the pair of vertical grooves 5, a pair of vertical partitions 6 removably placed therein and made a less height than the interior of the box, and a cover 9 inclosing the central chamber formed by such partition, substantially as set forth.

2. A refrigerator shipping box or case, comprising in combination a box or case, the end walls 2 of which are formed with the pair of vertical grooves 5, a pair of vertical partitions 6 removably placed therein and made in two sections, a main lower section and an upper supplementay section, and a cover 9 inclosing the central chamber formed by such partitions, substantially as set forth.

3. A refrigerator shipping box or case comprising in combination, a main box or case the end walls of which are formed with the pair of vertical grooves 5, the vertical partitions 6 removably placed therein, the cover 9, and the end cleats 10, inserted between the cover 9 and the main box cover 4, substantially as set forth.

4. A refrigerator shipping box or case comprising in combination, a main box or case the end walls of which are formed with the pair of vertical grooves 5, the vertical partitions 6 removably placed therein, the cover 9, and horizontal partition or bottom 11 removably supported by end cleats 12, substantially as set forth.

In testimony whereof witness my hand this 6th day of February, 1893.

Thomas Drummond.

In presence of Geo. J. Keenler, Robert Burns.

(Here follows photostat of side folio 487)

[fol. 488] United States Patent Office

Julius Rumpel, of Weston, Missouri

Receptacle.

1,130,932. Specification of Letters Patent. Patented Mar. 9, 1915

Application filed June 8, 1914. Serial No. 843,696

To all whom it may concern:

Be it known that I, Julius Rumpel, a citizen of the United States, residing at Weston, in the county of Platte and State of Missouri, have invented certain new and useful Improvements in Receptacles, of which the following is a specification.

My invention relates to improvements in lunch receptacles, and my object is to provide a simple device of this character, wherein lunches and sold drinks may be conveniently packed for picnic parties, etc.

The receptacle has an ice compartment and is made of air and waterproof material, so that when provided with ice and refreshments the same will be kept cold and fresh for a considerable period of time.

The device is made of inexpensive material, so that it may be thrown away after use if desired.

In order that the invention may be fully understood, reference will now be made to the accompanying drawing, in which:

DEFENDANT'S EXHIBIT H 9

487

J. RUMPEL.

RECEPTACLE.

APPLICATION FILED JUNE 8, 1914.

1,130,932. Patented Mar. 9, 1915.

Fig. 1.

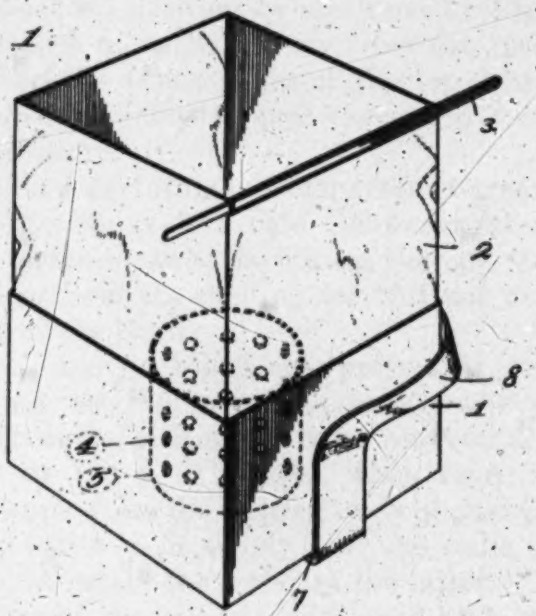


Fig. 2.

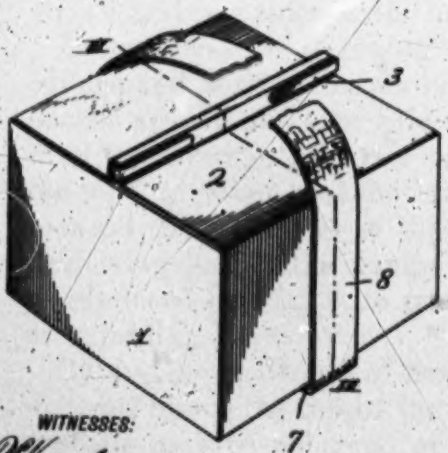
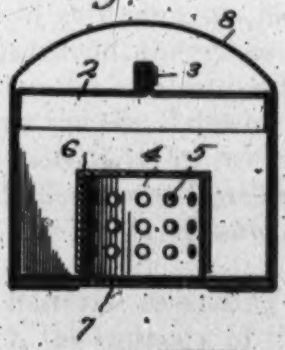


Fig. 3.



WITNESSES:

R. C. Hamilton

L. J. Fischer

INVENTOR:

Julius Rumpel,

BY

F. G. Fischer,

ATTORNEY.

Figure 1 is a perspective of the receptacle open ready for filling. Fig. 2 is a perspective of the receptacle closed. Fig. 3 is a section on line III—III of Fig. 2.

In carrying out the invention, I employ a box 1, made, preferably, of pasteboard or other stiff material.

2 designates an extensible top for the box 1, said top being made, preferably, of paper which can be readily folded into closed position as disclosed by Figs. 2 and 3, for the purpose of excluding air from the receptacle and contents thereof. One margin of the top 2 has a flexible metallic clip 3, suitably secured thereto to secure the top in closed position.

4 designates a perforate ice compartment arranged within box 1. Perforations 5 in said compartment are located some little distance above the bottom thereof, so that water accumulating from the melting ice will not overflow into the balance of the box 1.

The box 1 and its top 2 are, preferably, treated with waterproofing material, so that no damage will ensue should the water from the melting ice come into contact with said box 1 and its top 2. However, when food likely to be spoiled by water from the melting ice is packed in the box 1, I provide a cap 6 to fit snugly over the walls of the compartment 4, to retain the water in the latter.

The bottom of the box 1 is reinforced by a strip of stiff material 7, extending across said bottom and secured to the box by a fabric bail 8, pasted or otherwise secured to said strip 7 and two sides of the box 1.

In practice, ice is placed in the compartment 4, while edibles and bottles containing liquid refreshments may be packed around and over said compartment, the whole being firmly secured in place by bringing the opposite sides of the top 2 together, and then rotating the clip 3 downwardly to wind the two sides of the top thereon, after which the projecting ends of the clamps are folded toward each other, as disclosed by Fig. 2, to prevent the top from unwinding or unfolding.

By making the top 2 of flexible material extending some distance above the top of the box 1, the capacity of the receptacle may be enlarged or diminished according to the number of times said top is folded around the clip 3.

While I have shown and described the preferred form of my invention, I of course, reserve the right to make such changes in the construction, combination, and arrangement of parts as properly fall within the spirit and scope of the claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:

A box, a compartment of waterproof material mounted upon the bottom of the box and having a series of spaced rows of perforations formed therein, the lowermost row of perforations being spaced above the bottom of the compartment, and a cap detachably engaged over the compartment for covering the perforations to prevent liquid from the compartment entering the box.

In testimony whereof I affix my signature, in the presence of two witnesses.

Julius Rumpel.

Witnesses: F. G. Fischer, L. J. Fischer.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C.

(Here follows photostat of side folio 489)

[fol. 490] United States Patent Office

Stephen H. Emmens, of New York, N. Y.

Refrigerating and Refrigerant

Specification Forming Part of Letters Patent No. 652,759, Dated July 3, 1900

Application Filed July 15, 1899. Serial No. 723,948. (No Specimens.)

To all whom it may concern:

Be it known that I, Stephen Henry Emmens, a subject of the Queen of Great Britain and Ireland, and a resident

DEFENDANT'S EXHIBIT H 10

489

No. 652,759. Patented July 3, 1900.

S. H. EMMENS.

REFRIGERATING AND REFRIGERANT.

(Application filed July 15, 1899.)

(No Model.)

Fig. 1.

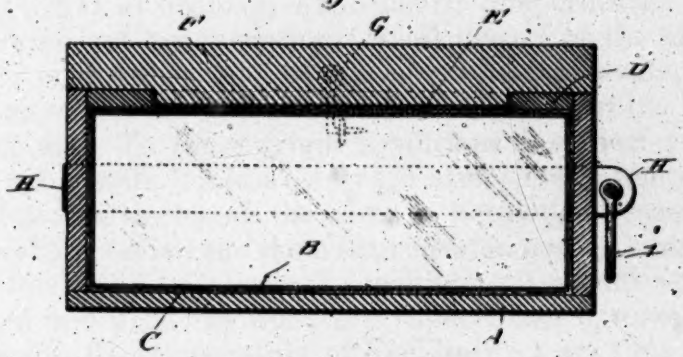


Fig. 2.

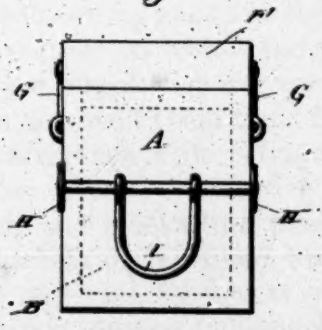


Fig. 3.

Witnesses:
Jesse E. Sater
Arthur C. Fraser

Inventor:
Stephen H. Emmens
by Dyer & Dyer
Attorneys.

of the borough of Richmond, in the city and State of New York, have invented a new and useful Improvement in Refrigerating and Refrigerants, of which the following is a specification.

My invention has for its object the preparation and use of refrigerating substances possessing a much greater cooling power than those hitherto employed in the arts or for the purposes of every-day life and not being capable of conversion into gas at ordinary atmospheric temperature.

In carrying out my invention I avail myself of the high degrees of cold which have of late years become available on a commercial scale by the manufacture of apparatus for liquefying air. To these frigid conditions I subject substances that remain liquid at average atmospheric temperatures after first inclosing the same in hermetically-sealed cans, so as to preserve the same for repeated use, as hereinafter set forth, and I continue the cooling until solidification is attained and until the same are superfrozen by cooling them down to the temperature of liquid air. I am thus enabled to prepare portable blocks of material containing varying amounts of cold—i. e., negative thermal units reckoned from the temperature to which the refrigerants are ultimately to rise when employed for cooling purposes—which blocks are then removed from their freezing environment and used as refrigerants in refrigerators, railroad cars, ships, and other places. In order to conveniently transport and use the said blocks in a preferred way, they are put in cases or jackets of felt-lined wood or other partially-heat-insulating material, by means of which the cans are protected from injury during transport and the cooling power of the blocks is regulated as to speed of action, and when such cooling power is exhausted the jacketed cans are returned to the charging-station, where by removing the cases and exposing the cans to the before-mentioned frigid conditions the blocks are reconstituted. In cases where the above-described blocks are required to be used for the purpose of providing a supply of ordinary ice I may provide the jackets with a recess in which a metallic tray of water may be placed in contact with the can containing the frozen or superfrozen refrigerant.

A sheet of drawings accompanies this specification as part thereof.

Figure 1 of these drawings represents a longitudinal section through an individual block of the improved refrigerant and its jacket. Fig. 2 is an end elevation of the jacket shown in Fig. 1; and Fig. 3 is a plan view of a shipping-case with the top removed, illustrating the method of transporting cooling power in greater quantities.

Like letters refer to like parts in all the figures.

My refrigerant is used in the form of one or more blocks B, preferably and conveniently rectangular in shape, each block consisting of a hermetically-sealed sheet-metal receptacle or can filled with a superfrozen liquid or solution, as above described.

The jacket suitable for ordinary use (represented in Figs. 1 and 2) consists of a rectangular wooden case A, having on one side a rectangular opening through which the block B of the refrigerant can be introduced into the interior of the case, which is conformed thereto and has a felt lining C. A quadrangular frame or distance piece D fits into the opening of the case and forms within it a recess in which is placed a metallic tray E. A felt-lined lid F fits inside the tray and forms one side of the case, being connected with the body of the case by suitable fastenings, as hooks and staples G. A stirrup-shaped metallic strap H and a handle I at the open end of the strap provide convenient means by which to lift and handle the jacketed block. When a supply of ice is required, the lid F is removed and the tray E is filled with water and then covered with the lid turned top downward.

In the transportation of cooling power in greater quantities a number of metal-clad blocks B are preferably and conveniently packed side by side without interstices of substantial extent within a shipping-case A, having a felt lining C, as in Fig. 3.

The substances that I employ for the manufacture of my improved refrigerants are water, brine, cryohydrates—that is to say; saline solutions of such a strength in each par- [fol. 491] ticular case as to have a minimum freezing-point —alcohols, and mixtures of water with glycerin or alcohol, or both. For example, by exposing water to the low temperatures obtainable by means of a liquid-air apparatus I manufacture superfrozen ice having a temperature of 300° below zero Fahrenheit. One pound of this substance in ris-

ing to 42° Fahrenheit will absorb three hundred and fifteen thermal units, whereas a pound of ordinary ice as supplied to domestic refrigerators will absorb only one hundred and fifty-four units. By my invention I am thus enabled to more than double the cooling power of ice, thereby effecting a great economy of weight, bulk, and expense. The substance, however, that I prefer to employ is a liquid which I name "glyce" and which consists of fifty per cent. of water and fifty per cent. of glycerin. It freezes at about 23° below zero Fahrenheit and has a specific heat greater than that of ice. One pound of glyce, if superfrozen to 300° below zero Fahrenheit, is capable when acting as a refrigerant and rising to 42° Fahrenheit of absorbing three hundred and fifty-eight thermal units, thus being considerably more efficient than superfrozen ice.

For special purposes the refrigerant may be put up in cylindrical, spherical, and other shapes, as well as in rectangular blocks of any desired proportions, and other like modifications will suggest themselves to those skilled in the art.

I am aware that for the purpose of regulating the action of refrigerating apparatus it has been proposed to include in such apparatus stationary closed cans or receptacles containing a liquid having the function of alternately freezing and thawing to a greater or less extent dependent upon the excess or defect of negative heat in the circulating refrigerant as compared with the atmosphere or other matter to be cooled. This, however, is entirely distinct from my invention, which does not consist in any system of regulation, but is an entirely new method of utilizing the new material —"liquid air"—for the production of a refrigerant available for general use in the form of portable blocks.

The term "hermetically" as herein used is intended to mean tightly with reference to preventing leakage without limitation as to the mode of sealing. The term "superfrozen" is intended to mean reduced below the normal solidifying temperature of the liquid to the temperature of liquid air at normal atmospheric pressure.

Having thus described said improvement, I claim as my invention and desire to patent under this specification—

1. The method of producing refrigerants in the form of portable blocks consisting in hermetically inclosing a non-

volatile liquid within sheet-metal cans, and superfreezing the same by exposure to the cooling action of liquid air.

2. The method of producing refrigerants in the form of portable blocks consisting in hermetically inclosing a mixture of water and glycerin within sheet-metal cans, and super-freezing the same in the manner herein specified.

3. A refrigerant in the form of a portable block consisting of a superfrozen non-volatile liquid hermetically inclosed within a sheet-metal can.

4. A refrigerant in the form of a portable block, consisting of a superfrozen mixture of water and glycerin hermetically inclosed within a sheet-metal can.

Stephen H. Emmens.

Witnesses: Newton W. Emmens, William Molloy.

(Here follows photostat of side folio 492)

[fol. 493] Patented Nov. 11, 1924. 1,515,119

United States Patent Office

Walter S. Josephson, of New York, N. Y., Assignor to B. M. J. Utilities, Inc., of New York, N. Y., a corporation of New York

Refrigerating Device

Application Filed October 3, 1922. Serial No. 592,072.

To all whom it may concern:

Be it known that I, Walter S. Josephson, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented a new and useful Refrigerating Device, of which the following is a specification.

The object of my invention is to provide a portable device capable of convenient attachment to a cylinder of carbonic

DEFENDANT'S EXHIBIT H 11

492

Nov. 11, 1924.

1,515,119

W. S. JOSEPHSON

REFRIGERATING DEVICE.

Filed Oct. 3, 1922

Fig. 1.

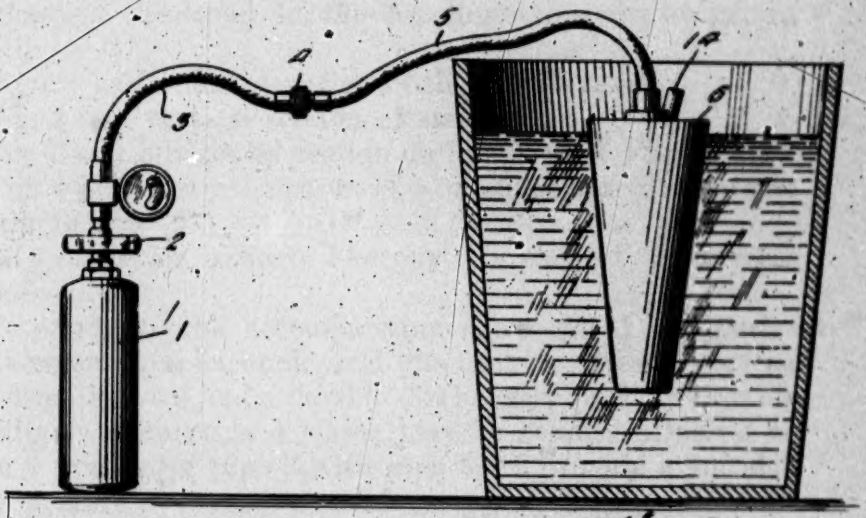


Fig. 2.

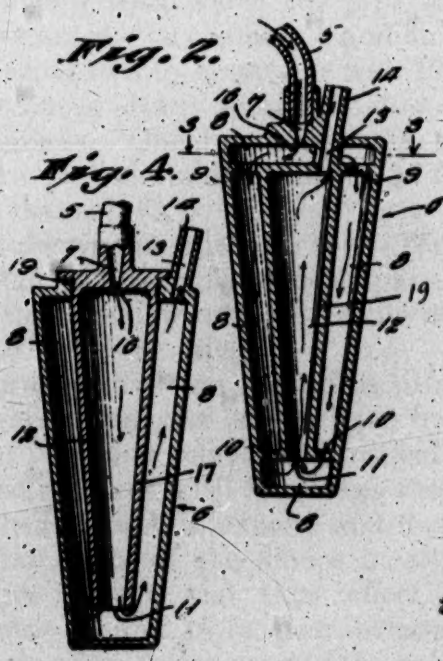
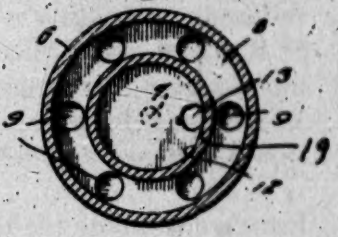


Fig. 4.

Fig. 3.



Inventor
Walter S. Josephson

By Lester L. Sargent.
Attorney

acid or other compressed and liquefied gas. It is an especial object of my invention to provide a device which can be conv-iently utilized by automobile tourists whereby the compressed gas container which is provided for other purposes, such as the inflation of tires, etc., may also be used for the purpose of a readily portable refrigerating device. I attain these and other objects of my invention by the mechanism disclosed in the accompanying drawings, in which—

Figure 1 is a side elevation of the device in use;

Fig. 2 is a vertical section of same;

Fig. 3 is a horizontal section on line 3—3 of Fig. 2; and

Fig. 4 is a vertical section of a modification of the form shown in Fig. 2.

Like numerals indicate like parts in each of the several views.

Referring to the accompanying drawings, 1 designates the conventional carbonic acid gas tank or cylinder having the usual valve 2 and a flexible discharge pipe 3. I provide a suitable connection 4 which may be readily attached to pipe 3 to connect pipe 3 with pipe 5. I provide a suitable and preferably frusto-conical casing 6, having an inlet channel 7 with which the pipe 5 connects. I provide an outer expansion chamber 8 and an inner expansion chamber 12, separated by a suitable wall 19. Inlet 7 has a mouth 16 of reduced size to retard the flow of gas into the expansion chambers. Opening out of the upper end of chamber 6, I provide a suitable extension 14 for the gas escape or outlet channel 13.

Referring particularly to the form of the invention shown in Fig. 2, I provide suitable passages 9, 10 and 11 for the continuous flow of the refrigerant from one expansion chamber to the other.

In operation the flow of gas or refrigerant into the refrigerating device is restricted by the narrow mouth 16 of inlet 7 so as to retard the liquefied or partially liquefied gas or refrigerant until it reaches the refrigerating device. It is then allowed to expand and thus reduce the temperature of the walls of the device in either of the forms of the device shown, and thus effect the refrigeration. The mouths 14 and 18 in each instance are of relatively large size to allow free escape of the gas, these mouths being posi-

tioned above the rest of the device so that the device itself may be immersed in any container of fluid which it is desired to chill.

In the form of the device shown in Fig. 2, inlet 7 opens into chamber 8, the gas thus flowing into chamber 12 and out through outlet 13, as indicated by the arrows.

In the form of the device shown in Fig. 4 the inlet opens into the inner chamber 16 and thence flows out to the outer chamber 8 and ouflet 13.

In the form of the invention shown in Fig. 4, the inner wall 17 is provided with a threaded portion 19 whereby it is secured to the outer wall 6 in the manner shown, thereby providing a construction which can be manufactured at less cost than the form of the device disclosed in Fig. 2.

What I claim is:

1. In a device of the class described, an expansion chamber having an outer wall of frusto-conical form, of an inner spaced wall of like form, the chamber within said inner wall being in open communication at the lower end with the chamber intermediate of the two walls, an inlet having a reducing valve for the inflow of refrigerant to one of the chambers, and an outlet having a mouth of relatively large size for the outflow of expanded gas from the other of the two chambers, and means for detachably connecting the apparatus with a suitable source of supply of a liquefied gas.

2. In a refrigerating device using a liquefied gas as the refrigerant, a refrigerating chamber comprising spaced frusto-conical walls, the chambers formed by said walls being in open communication at the lower end of the device, an inlet opening into the outer chamber, said inlet including a reducing valve arranged in the outer wall of the chamber to permit of expansion of the refrigerant on entering the chamber, said chamber having a relatively large outlet opening out of the inner chamber and communicating direct [fol. 494] with the outside atmosphere, and means for detachably connecting the apparatus with a suitable source of supply of a liquefied gas.

3. In a device for utilizing a liquefied gas as a refrigerant, the combination of an expansion chamber having spaced walls of frusto-conical form, the chambers formed by said walls being in open communication at their lower

end, a relatively large outlet opening out of one of the chambers direct to the outside atmosphere and in a plane above the uppermost wall of the chamber, an inlet opening into the other chamber, said inlet including a reducing valve arranged in the wall of said chamber, and a conduit for operatively connecting the device with a suitable source of supply of a liquefied gas, said pipe including suitable detachable connections, substantially as shown and described.

Walter S. Josephson.

[fol. 495] DEFENDANT'S EXHIBIT H 12

United States Patent Office

Edward N. Dickerson, Jr., of New York, N. Y.

Process of Refrigerating and Preserving Meat and Other Articles

Specification Forming Part of Letters Patent No. 256,299, Dated April 11, 1882

Application Filed March 2, 1882. (No specimens.)

To all whom it may concern:

Be it known that I, Edward N. Dickerson, Jr., of the city, county, and State of New York, have invented a new and useful Improvement in Processes of Refrigeration and Preserving Meat and other Articles, of which the following is a full, true, and exact description.

It is well known that putrescible substances may be partially preserved from deterioration or decay by subjecting them to atmospheric air reduced to a low temperature. It is also well known that the decay of putrescible substances may be retarded by subjecting them to the action of certain gases destructive of certain ferment-germs—as, for instance, carbonic oxide. Neither of these processes will, however, entirely accomplish the results sought to be obtained. Meat, for instance, cannot be preserved by subjecting the same to air reduced to a low temperature in such a condition as to maintain its natural bloom or appearance. Certain ferments act upon its surface, even at

the low temperature proposed, and tend to change its color and destroy it. On the other hand, bodies subjected to the action of preservative gases—such as carbonic-oxide—at their ordinary temperatures, cannot in all instances be successfully preserved. There seem to be two classes of ferments, one of which is destroyed or rendered inactive by cold, but not by carbonic oxide, and the other of which is destroyed or rendered inactive by carbonic oxide, but not by cold.

I have discovered that almost absolute preservation of putrescible bodies can be accomplished by subjecting them to the influence of carbonic-oxide or similar decay-preventing gas reduced to an abnormally low temperature.

In carrying out my invention practically I take carbonic oxide and nitrogen, preferably that prepared and purified according to the patents of C. F., A. W., and A. L. Lawton, dated May 17, 1881, No. 241,677, for process of preserving organic substances, and June 7, 1881, No. 242,546, for preserving purposes, and then subject those gases to refrigeration in a compression and expansion apparatus, preferably such as is patented to J. J. Coleman, April 6, 1880, No. 226,281, although other apparatuses might be used. I consider it important, however, to use an apparatus which will deposit out of the gas any superfluous moisture which it may contain.

In place of using such apparatus for producing cold by power, I might use natural refrigerants—such as ice. In this case I prefer that the preservative gas should not come in direct contact with the ice, but should be refrigerated by passing through a system of tubes chilled by ice. These tubes might be so arranged as to cause a natural circulation, or a blower might be employed for insuring a forced circulation of the gas through the refrigerating-chamber. The gas might be brought into direct contact with the ice, as in the well-known Lyman refrigerator; but I prefer the other forms shown.

In employing either of the above methods a supply of the gas should be provided in an independent chamber, which can be used to constantly maintain the gas within the refrigerating-chamber. A certain amount of leakage necessarily occurs, and it is better, though not necessary, to have a pressure within the refrigerating-chamber slightly in ex-

DEFENDANT'S EXHIBIT H 13

496

A. P. LUNDIN.

HEAT INSULATING STRUCTURE.

APPLICATION FILED JUNE 24, 1913.

1,133,299. Patented Mar. 30, 1915.

Fig. 1.

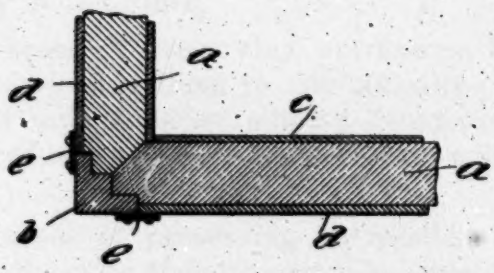
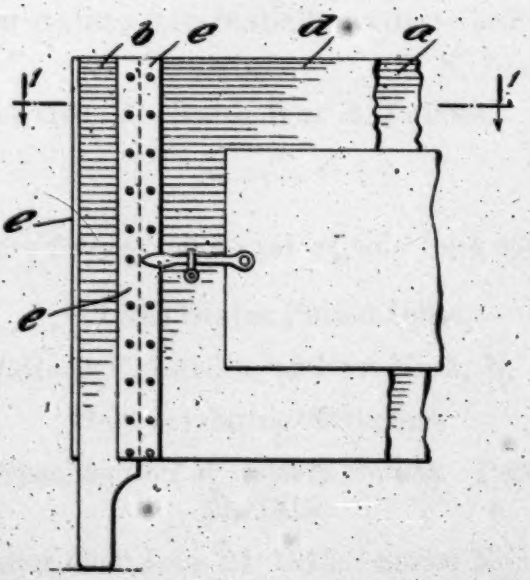


Fig. 2.



Witnesses:

Sydney F. Chittenden

Andreas P. Lundin, Inventor

By his Attorney

Wade Brown

cess of the barometric pressure, so as to maintain the purity of the gas in the chamber.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The process of preserving putrescible bodies which consists in subjecting them to carbonic-oxide or similar decay-preventing gas artificially reduced to a low temperature, substantially as described.

2. The process of preserving putrescible bodies which consists in subjecting them to mechanically-produced currents of carbonic-oxide or similar decay-preventing gas, substantially as described.

3. The process of preserving putrescible bodies which consists in subjecting them to mechanically-produced currents of carbonic-oxide or similar decay-preventing gas artificially reduced to a low temperature, substantially as described.

4. The process of preserving putrescible bodies which consists in subjecting them to carbonic-oxide or similar decay-preventing gas at a greater pressure than the external barometric pressure, said gas being artificially reduced to a low temperature, substantially as described.

E. N. Dickerson, Jr.

Witnesses: Geo. H. Evans, Wm. A. Pollock.

(Here follows photostat of side folio 496.)

[fol. 497] United States Patent Office

Andreas P. Lundin, of New York, N. Y.

Heat-insulating Structure

1,133,299. Specification of Letters Patent. Patented Mar. 30, 1915

Application filed June 24, 1913. Serial No. 775,523

To all whom it may concern:

Be it known that I, Andreas P. Lundin, a citizen of the United States, and a resident of the borough of Queens,

county of Queens, city and State of New York, have invented an Improved Heat-Insulating Structure, of which the following is a description in such full, clear, and exact terms as will enable any person skilled in the art to which it pertains to make and use the same.

My invention relates to the construction of refrigerators or structures designed to prevent the transmission of heat to goods stored therein and which goods it is desired to keep in a cold or refrigerated condition. An example of such structures is to be found in the well known household refrigerator used for the preservation of foods and the like. Ordinarily in structures of this sort two essential elements are always to be found, to wit: a frame contributing the necessary mechanical strength to the structure and a heat insulating means, which latter is usually such material as cork, in solid or granular form, fibrous materials, sawdust and similar substances. But in no instance in refrigerator construction known to me have these two effects, structural or mechanical strength and insulation, been found combined in a single, unitary element, with the possible exception of an ordinary pine wood box, and this is not fairly a refrigerator because its degree of heat insulation is negligible and for this reason not within the purview of my invention.

I have discovered that a heat insulating structure such as that to which my invention relates may be constructed wholly of balsa wood, which single material or element combines the two functions above referred to, that is to say, the functions of furnishing the mechanical strength by which to hold the structure together permanently and of furnishing the insulation or non-heat-conducting effect necessary to refrigeration to a degree at least equal to the degree of insulation attained in the best constructed cork or fiber insulated refrigerators. In other words, according to my invention, I build the heat insulating structure substantially of balsa wood and by this alone I make the structure strong and durable from a mechanical standpoint and give to it a degree of heat insulating capacity equal to or exceeding that afforded by the best form of cork or fiber packing in refrigerators of the usual construction. The balsa wood referred to is found in tropical America. Its botanical name is *Ochroma Lagopus*. It is a tree which

grows to about the size of the North American pine. The wood is of extremely light weight and of very peculiar formation. It is composed almost exclusively of pith fibers running longitudinal and transversely and themselves made up of short barrel-shaped cells with extremely thin walls which endow it with the power of heat insulation which I have discovered. These fibers are closely interlaced and I have found them to be remarkably tough and elastic so that the wood posseses a mechanical strength approximating that of spruce or pine. When this wood is properly treated by a water-proofing compound it furnishes one of the best known heat insulating materials and its mechanical strength enables me to construct a heat insulator building or refrigerator exclusively of this wood and thereby combine in one element those functions which heretofore have been performed by two elements, to wit, the frame or supporting part of the building and the refrigerating element of the cork, saw-dust, felt or other heat insulating material.

The accompanying drawings illustrate as an example the preferred manner of adapting my discovery to practical construction of a household refrigerator.

In these drawings: Figure 1 is a sectional plan on the line 1—1 of Fig. 2 and Fig. 2 is a fragmentary elevation of the refrigerator.

Referring to the drawings a indicates the walls of the refrigerator which are formed of balsa wood of suitable thickness either integral or formed of several layers or laminations, these walls being morticed into corner posts b also of balsa wood, which posts extend down to form the legs or supports. These two elements a and b, or their equivalents arranged in any convenient way, constitute the whole of the essentials of the structure. By their means the refrigerator is given mechanical or structural strength and owing to the heat insulation properties of the balsa wood the refrigerator is given a degree of non-heat conductivity equal to that of any form of heat insulation heretofore known. If desired the refrigerator may have a lining [fol. 498] c of any kind of sheet material which serves only to provide a sanitary surface for contact with the food or other substance contained in the refrigerator.

To provide a desirable exterior finish for the structure I prefer to face it with panels d which meet the sides of the posts b, the meeting edges being covered with battens e of suitable material. These panels d are formed from pulp of the balsa wood with a sufficient quantity of its bark to supply the necessary long fibers. This pulp is formed into sheets after any of the usual methods of mill board formation and is preferably sized or otherwise treated to render it impervious to moisture and susceptible to sufficient polish to give the panels a proper degree of finish or ornamentation. The walls a and posts b (and such other balsa wood parts as may be employed) are surface treated or coated by any suitable method for the purpose of closing the air cells and preventing absorption of moisture thereby.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

As a new article of manufacture, a substantially air-tight container, constructed to contain perishable matter and preserve the same at a low temperature by means of a refrigerant contained therein, all the walls of said container being composed substantially entirely of water-proofed balsa wood, whereby the structural strength and heat insulating effects are united in a single element.

In testimony whereof I have hereunto signed my name in the presence of two witnesses.

Andreas P. Lundin.

Witnesses: Arthur Vehlow, Sydney H. Giellerup.

(Here follows photostat of side folio 499)

[fol. 500] United States Patent Office

Victor Crémieu, of Paris, France

Method of Cooling Liquids and Charging the same with Gas by the Use of Snowlike Carbonic Anhydride

1,421,176. Specification of Letters Patent. Patented June 27, 1922

DEFENDANT'S EXHIBIT H-14

499

V. CRÉMIEU.

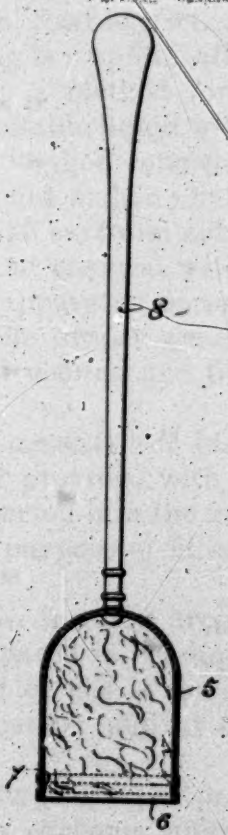
METHOD OF COOLING LIQUIDS AND CHARGING THE SAME WITH GAS BY THE USE OF SNOW LIKE CARBONIC ANHYDRIDE.

APPLICATION FILED NOV. 11, 1920.

1,421,176. Patented June 27, 1922.

fig. 1

fig. 2



INVENTOR
VICTOR CRÉMIEU
BY Munn & Co.
ATTORNEYS

Application filed November 11, 1920. Serial No. 423,440

To all whom it may concern:

Be it known that I, Victor Crémieu, a citizen of the Republic of France, and residing at Paris, Seine Department, No. 54 Faubourg Saint-Honoré, in the Republic of France, have invented certain new and useful Improvements in Methods of Cooling Liquids and Charging the Same with Gas by the Use of Snowlike Carbonic Anhydride (for which I have filed applications in France, Oct. 22 and Nov. 28, 1919), of which the following is a specification.

This invention relates to a method for simultaneously cooling and charging any suitable liquid with gas, and more particularly a drink. The method consists in principle in maintaining within said liquid and in contact therewith a suitable quantity of snow-like carbonic anhydride until the liquid is properly cooled and charged with gas. This invention also relates to an apparatus permitting the maintenance in said liquid of the proper amount of snow-like carbonic anhydride used for cooling and for charging with gas.

A device of this nature consists for instance of a perforated bell-shaped member provided with a handle whereby said member may be inserted into the mass of snow-like carbonic anhydride for the purpose of filling the same with this substance.

This invention consists in forming around the mass of snow-like substance to be placed in the liquid a film of ice whereby the disengagement of gas is prevented from taking place in a turbulent manner and at an unduly rapid rate.

The entire device consisting of a perforated bell-shaped or like member, snow-like carbonic anhydride disposed therein and an outer film of ice, thus constitutes a new product which may be employed in a practical, convenient and advantageous manner, and especially for the preparation of cold and sparkling drinks.

When melting, the snow-like carbonic anhydride absorbs a quantity of heat resulting in a frigorific action which is substantially double the effect produced by an equal weight of ice, and if thereof a mass of such snow-like substance is

maintained at the bottom of a glass of water, for instance, carbonic acid will be produced for charging the water, together with a considerable cooling effect.

For instance eight grammes of said snow-like substance will introduce into water 1200 frigories and 4 liters of gas, which is sufficient for the charging of an average sized glass of water and for lowering the temperature to 4° centigrade.

The accompanying drawing shows by way of example a constructional form of a device according to this invention.

Fig. 1 is an elevation of the first constructional form.

Fig. 2 shows the second constructional form partly in elevation and partly in section.

This device consists of a small bell-shaped member 1 (Fig. 1) provided with a handle 2 and having therein the small apertures or narrow slots 3 in considerable number, through which the carbonic acid gas is given off as the snow-like substance melts, the device being more particularly adapted for the cooling of drinks. But it has been remarked that in spite of the precautions which may be taken and the form adopted, the gas is given off in a turbulent manner and in large bubbles, whence it results that the liquid is imperfectly charged with gas. On the other hand, when the fusion of the snow-like block is already in the advanced stage, small particles of the substance become detached from the mass and float upon the surface, thus causing an inconvenience.

Experience proves that such inconveniences may be obviated by covering the bell-shaped member filled with snow-like substance with a film of ice. For this purpose it will suffice to immerse said bell-shaped member in a liquid which has been previously cooled to a point near its temperature of solidification. In this case the solidification will take place around the walls of the bell-shaped member which thus becomes covered with a uniform layer of ice through which the gas is now given off only in the shape of fine bubbles. If the bell-shaped member is allowed to remain for a sufficient length of time in the previously cooled liquid, the regulating layer of ice may reach several millimeters thickness.

A bell-shaped member thus prepared which is placed in a glass containing a drink will exert a double action by charg-

ing the liquid with gas and by cooling the same. It is of course understood that said bell-shaped members may be [fol. 501] constructed in any suitable manner and may be given the most varied forms.

In the preferred construction, the bell-shaped members and the handle thereof may be manufactured by the lathe turning process from a piece of light wood, thus obtaining a very inexpensive device, and each consumer may destroy the bell-shaped member after use in the same manner as for a piece of straw employed for drinking purposes.

The dimensions of the device are calculated in such manner that said member is filled with the snow-like substance by introducing it with the open end down into a vessel filled with said substance and exerting a slight pressure by hand, whereby the member is caused to contain the required amount of the substance, for instance about eight grammes for a glass of drink. One or more apertures 4 are preferably provided at the top of the bell shaped member to provide for the escape of gas in the event of an excess of pressure caused by the resistance which the outer covering affords to the disengagement of carbonic acid gas, and to obviate the breakage of the bell shaped member under the effect of an excessive internal pressure.

A considerable number of such devices covered with ice by the hereinbefore described method may be prepared in advance and preserved in heat protecting receptacles such as Dewar vessels for the space of several days, and they will afford a substitute for a soda water supply bottle and for ice.

According to the second constructional form (Fig. 2) the apparatus consists of a metallic bell-shaped member provided with a handle. The bell 5 is made of stamped metal, and is closed by a cover 6 made of thin stamped metal, the rim of which is set in a bezel and engages a circular groove 7 provided above the edge of the bell. The handle 8 may be fixed at the top of the bell in a suitable manner.

When the apparatus, filled with carbonic anhydride, is immersed in a liquid, the gas set free by evaporation of the carbonic anhydride escapes in form of fine bubbles through the circular interstices which remains between the cover and the edge of the bell.

It is of course understood that the use of such devices is not limited to their application to drinks, and by suitably varying the size and shape of the bell-shaped members, these latter may be made the subject of industrial applications in the preparation of alimentary products.

Claims—

1. A method for simultaneously cooling and charging a liquid with gas, consisting in maintaining within said liquid and in contact therewith a suitable quantity of snow-like carbonic anhydride.

2. In a method for simultaneously cooling and charging liquids with gas, the immersion of a measured quantity of snow-like carbonic anhydride in those liquids previously brought to a temperature near the point of solidification thereof, said immersion having for its object the formation of a film of ice surrounding said quantity of snow-like substance whereby the disengagement of carbonic acid gas shall be moderated.

In testimony that I claim the foregoing as my invention I have signed my name in presence of a subscribing witness.

Victor Crémieu.

Witness: Maurice Rowe.

[fol. 502] DEFENDANT'S EXHIBIT I

Detroit, Mich., May 23rd, 1923.

Mr. A. L. Miller, Commodore Hotel, New York, N. Y.

DEAR SIR: Just a word to advise you of the progress I am making on both the small counter machine and one freezing box for refrigerators, this will have a few improvements over the one you saw at the Hupp.

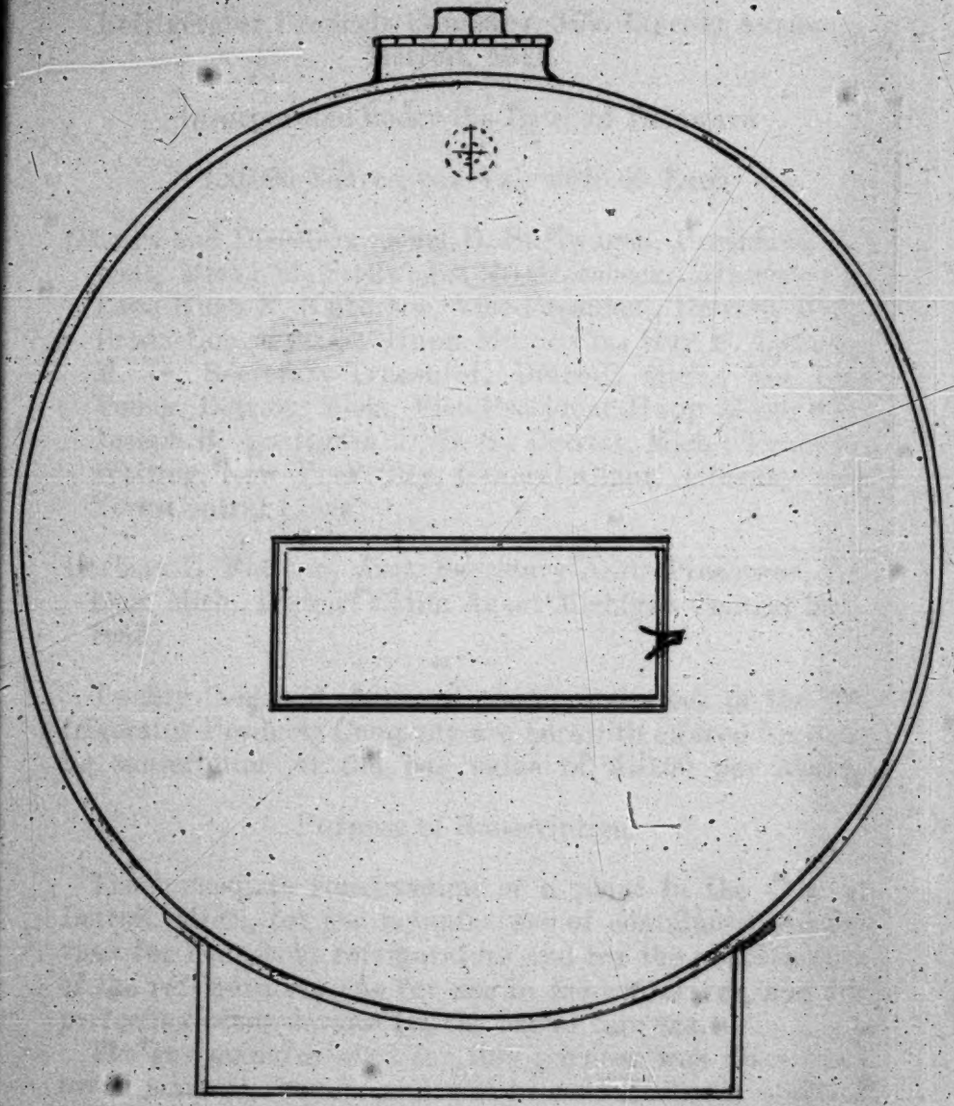
I will do my best to ship it to you by the middle of the week, I will also send you blue prints of same and one of the ice cream carrier. At the present I am working till nine each night with a draftsman on this work, hoping this will interest you.

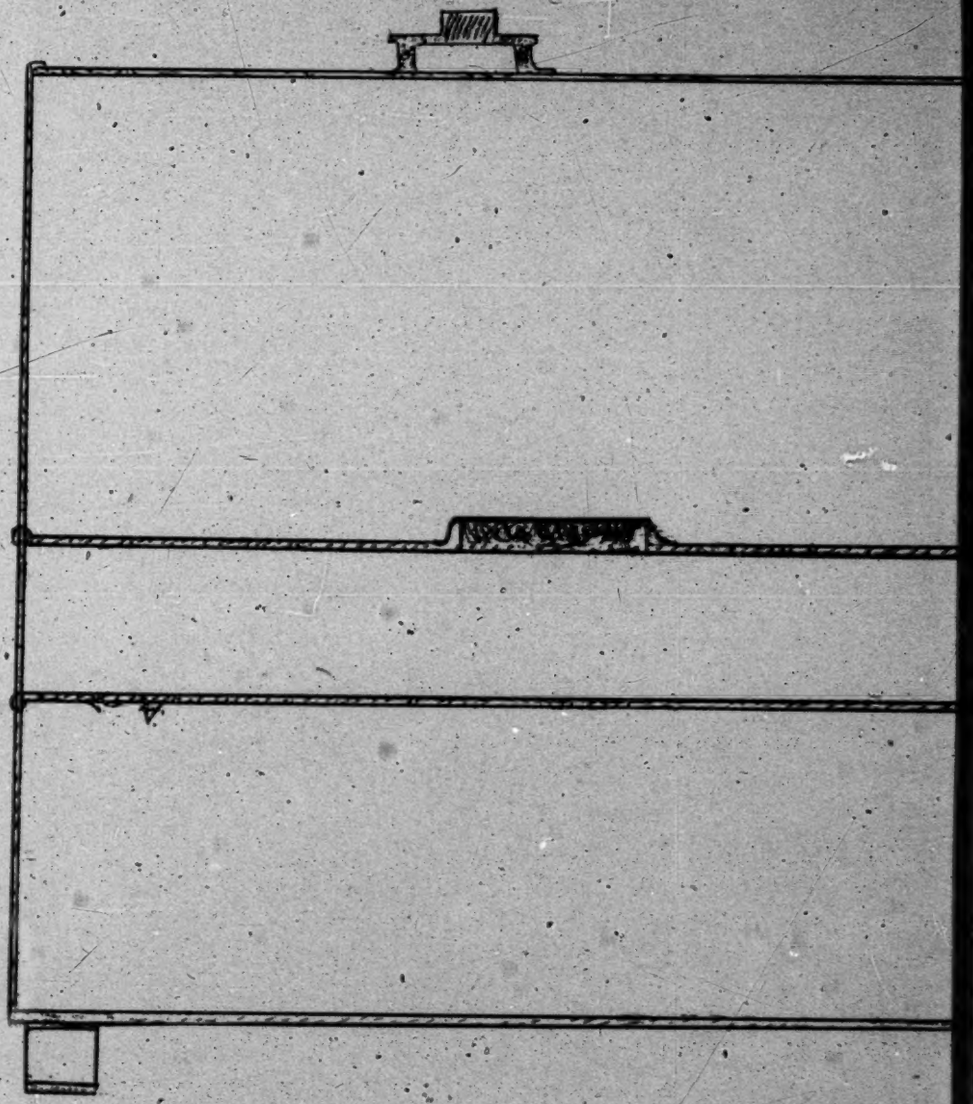
I am,

Very truly yours, (Sgd.) J. P. Lavigne.

(Here follows photostat of side folio 503)

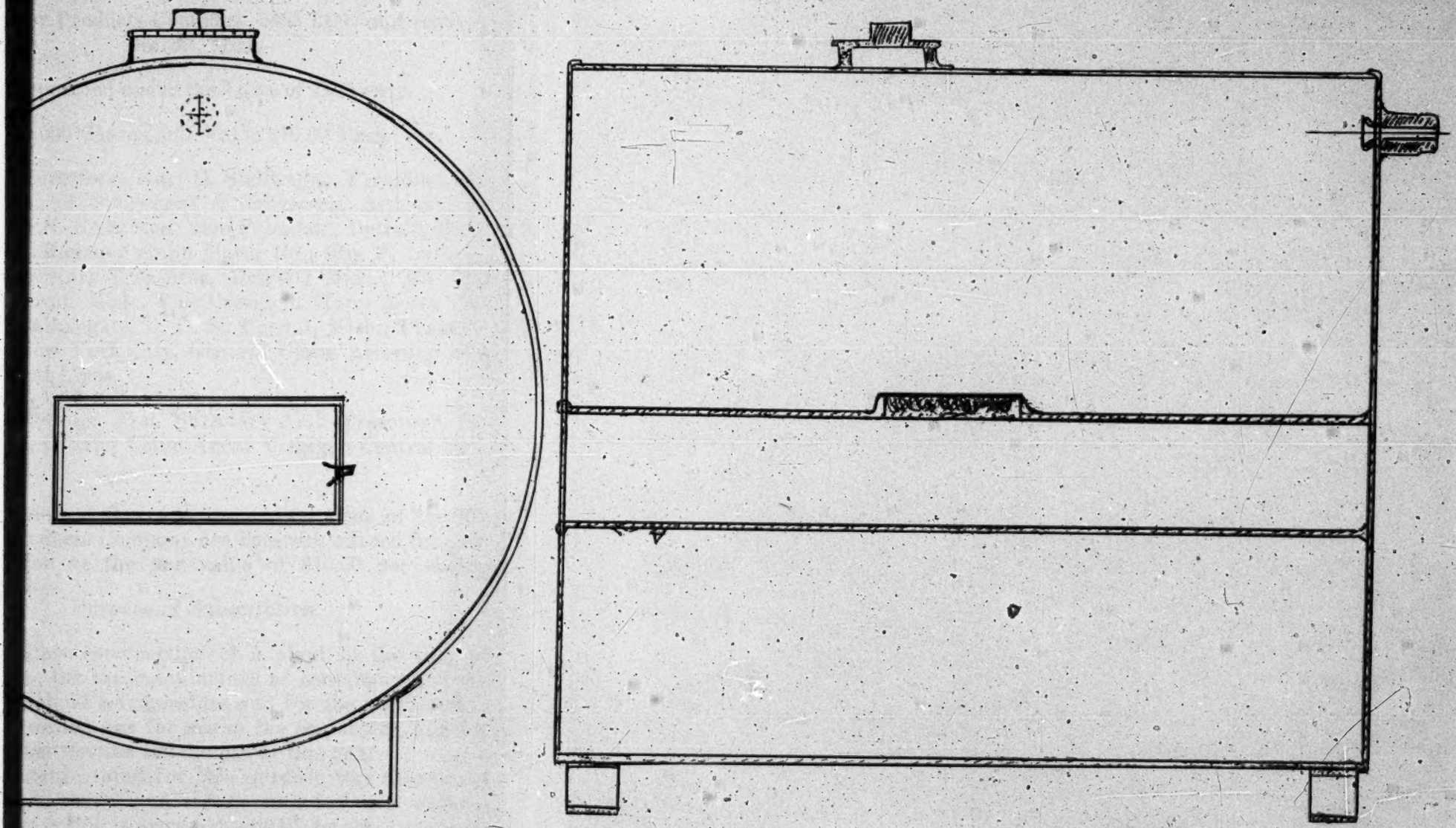
DEFENDAN





503

DEFENDANT'S EXHIBIT K



[fol. 504] DEFENDANT'S EXHIBIT M

Refrigerator Products Company, 5465 Lincoln Avenue, Detroit, Mich.

Incorporated under the Laws of Delaware

150,000 Shares, par Value $10.00 Each

Officers and Directors: Karl D. Stellwagen, President, Detroit, Mich., of Stellwagen & Grossbeck, Attorneys at Law; Hugh N. Nickerson, Vice-President, Detroit, Mich., Production Manager Hupp Motor Co.; Guy F. Lathrop, M. D., Secretary-Treasurer, Detroit, Mich.; Du Bois Young, Detroit, Mich., Vice-President Hupp Motor Co.; Joseph R. Applegate, D. D. S., Detroit, Mich.; Frank V. Whiting, New York City, General Claim Attorney New York Central Lines.

Herbert L. Forman, Asst. Secretary-Asst. Treasurer, Detroit, Mich., District Claim Agent Michigan Central Railroad

Twenty thousand shares of the capital stock of the Refrigerator Products Company are herewith offered for public subscription at the par value of $10.00 per share.

Purpose of Subscription

The immediate construction of a plant in the City of Detroit, Mich., for the manufacture of containers and devices for household refrigerators and for the manufacture of the refrigerating gas for use in the containers, and for perfecting other devices for the use of this gas.

The gas manufactured for this purpose was discovered by an eminent chemist and will be manufactured under a secret formula, which is owned absolutely by this Company. The Detroit Testing Laboratory attests to its being odorless, colorless, tasteless, non-explosive and does not support combustion (see letter following).

This gas when used in our containers will maintain an even temperature of 42 degrees above zero in the food compartment of any refrigerator, and is absolutely harmless and non-poisonous.

The engineers of the Company are at the present time working on a model for use in railroad refrigerator and dining cars, which will very materially cut the cost of this class of refrigeration.

There are many forms of refrigeration to which this system may be applied, which will be taken up later.

Your attention is called to the letter of the President as well as the others following.

[fol. 505] Law Office of Stellwagen & Groesbeck, Detroit, Mich.

A. C. Stellwagen, A. J. Groesbeck, K. D. Stellwagen

Statement by the President

February 27, 1924.

The Refrigerator Products Company is a Delaware corporation organized for the purpose of manufacturing a refrigerant gas and appliances for use with it. The capitalization is 150,000 shares, par value $10.00 each fully paid in and non-assessible. One-half of this stock was issued in payment of all the rights, title and interest in the formula for making this gas and in payment for the appliances for its use, together with an assignment of certain patent applications covering all the patentable features.

There are 75,000 shares in the Treasury of which the Board of Directors has authorized the sale at this time of 20,000 shares.

The company has developed a container adjustable to the ice compartment of the ordinary type of domestic refrigerator. This container, in addition to cooling the refrigerator has two trays, each with a capacity of 24 cubes of ice, which can be frozen within a very short time.

The gas, when liberated in the container, creates in special compartments, provided for the purpose, blocks of snow at a temperature many degrees below zero. The gas tank is connected directly with the container and the flow of gas is automatically controlled by the formation and evaporation of the snow in the compartment.

This operation is entirely automatic and requires no electric or other power, the operation being controlled entirely

by an arrangement of tubes, which is covered by one of the patent applications.

The container is so constructed that the radiation of cold air can be regulated to furnish the same amount of refrigeration as would be supplied by a given quantity of ice.

The gas used is odorless, non-inflammable, non-explosive and non-poisonous. In other words, it is absolutely harmless.

It is also kept at a sufficient low pressure so that an accident or injury of any sort to the container, piping or other mechanical parts of the apparatus could not cause an accident of any seriousness.

Gas tanks or tubes containing a sufficient supply of gas to operate an ordinary domestic refrigerator upwards of sixty days are to be furnished by the company on a basis whereby empty tubes are to be exchanged for full tubes at a price which we estimate will be considerably below the cost of ice.

The ingredients necessary to make the gas can be secured in unlimited quantities throughout the United States, and we believe throughout all sections of the world.

As to the cost of manufacture of this gas, we would refer you to a letter from the Detroit Testing Laboratories, a copy of which is hereto attached. The Detroit Testing Laboratories have had sufficient experience in producing it, so that their figures are authentic.

The cost of the manufacture of the containers has been figured by persons in similar lines of business in the City of Detroit, and in quantities can be manufactured for less than $11.50 each.

The sale price fixed by the Company at present ($50.00) should show a reasonable sales profit after allowing for overhead and sales expenses.

The funds to be secured through the sale of 20,000 shares of the Treasury stock are to be used for the immediate construction of a gas plant in Detroit, Michigan, in the manufacture of containers and devices for household refrigeration.

Besides this, a reasonable sum is to be set aside for experimental work in connection with other uses—particularly in refrigeration of railroad cars.

It is our present intention to construct a second gas plant in Rochester, New York.

Refrigerator Products Company, by K. D. Stellwagen, President.

[fol. 506] The Detroit Testing Laboratory, Detroit, Mich.

February 28, 1924.

Refrigerator Products Co., 1805 Dime Bank Building, Detroit, Michigan.

GENTLEMEN: The gas of the formula submitted by your company has the following properties: odorless, colorless, tasteless, non-explosive, does not support combustion, and when used under proper conditions as a refrigerant in the form of snow, produces temperatures lower than minus 60 degrees F.

In our estimation this gas can be produced at a manufacturing cost of approximately 1.3 cents per pound, exclusive of any royalties on patents which may apply to the process.

The materials necessary to manufacture this gas can be secured in quantity in almost any part of the United States.

Yours very truly, The Detroit Testing Laboratory, per C. L. Snyder.

G. S.

J. P. Lavigne, Consulting Engineer and Designer, 521 Lincoln Avenue, Detroit, Mich.

February 27, 1924.

K. D. Stellwagen, President Refrigerator Products Co., Dime Bank Building, Detroit, Michigan.

DEAR SIR: Complying with your request wherein you ask me to give you the cost of manufacturing the Ice Tank which I have designed for your Company, I will state as follows:

I estimate that including material, labor, boxing ready for shipment, including overhead, the cost of manufacturing the first thousand boxes will be $11.40 each. I estimate that when your factory is fully equipped and running, a re-

duction of approximately 15% can be made. The special tools that will be necessary for the purpose of constructing the above tanks, will cost in the neighborhood of $6,000.00.

I wish to state, however, that I am now designing a tank for your company which will be as efficient as the present one, if not more so, and that the total cost of the new box will not exceed the sum of $6.00 per box or tank in lots of one thousand.

The special tools that will be required to manufacture the new box will be approximately the same, or $6,000.00.

Trusting that this information will answer your requirements, I am,

Sincerely yours, J. P. Lavigne.

[fol. 507] Hupmobile, Hupp Motor Car Corporation, Detroit, Mich., U. S. A.

February 28th, 1924.

Mr. K. D. Stellwagen, Pres. Refrigerator Products Corp., Dime Bank Building, Detroit.

Dear Sir: I have carefully checked over the estimate submitted by Mr. J. P. Lavigne and am perfectly satisfied that the box can be made for the figures submitted. In fact, I believe that Mr. Lavigne is a little low in the estimate of a 15% reduction in cost for quantity production.

I might say that I would not hesitate to accept an order for quantity production at his price.

Yours very truly, H. N. Nickerson.

[fol. 508] Defendant's Exhibit N

(Copy)

January 2, 1924.

Mr. G. J. Burns, c/o Burns Brothers, Stock Exchange Bldg., Philadelphia, Pa.

Dear Sir: I thank you very much for your check for $300.00 which was certified, and made it possible for me to get the money.

Now there is a balance due of $621.16 to the 29th day of November. If you will send me immediately, a check for the balance, you may deduct $50.00 from that account, and I hope you will take advantage of that $50.00, as I need the money very badly.

Now in regard to the yearly contract which I have with you, as Chief Engineer, it is evident that you are not going to need my services any longer, and if that is the case I am ready to make a deal with you to cancel this contract, as I have some parties here who are ready to back me on the refrigerator business, and of course if you are through with me or haven't any more use, there is no reason why you should pile up expenses of my services. Of course you appreciate that the contract that you made with me covered the assignment of the patents which had already been gotten up by me, and by me alone, so that the money that [fol. 509] you are now getting is all through my patents, as Mr. Bright of course never did get up anything at all and he has been getting a good deal of recompenses and money from my efforts and patents. So I hope you will decide to accept my proposition of terminating the contract at an early date, with some kind of a settlement. I will be very glad to come to Philadelphia for that purpose. There are quite a number of things, old samples and materials here, belonging to your organization, which I will be glad to send to you as soon as settlement can be arrived at.

Hoping to hear from you at an early date, I remain,

Yours very truly, —— ——.

(Here follow photostats of side folios 510 to 550, inclusive.)

[fol. 551] DEFENDANT'S EXHIBIT U

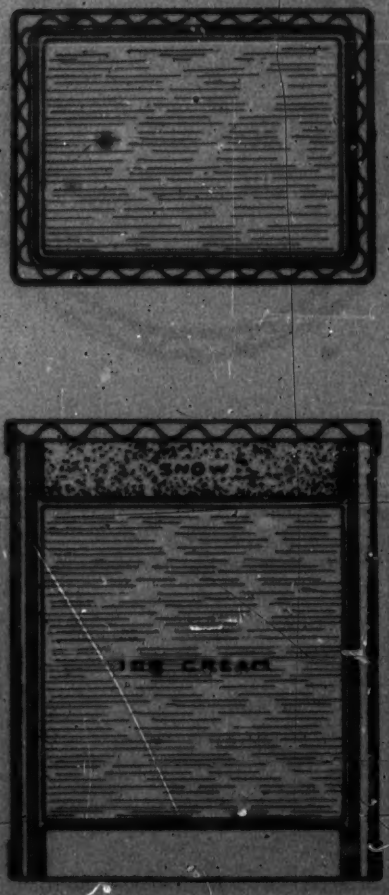
1923 Jun. 27 AM. 11 48.
UB331 78 Blue.

Detroit, Mich., 27, 10:17A.

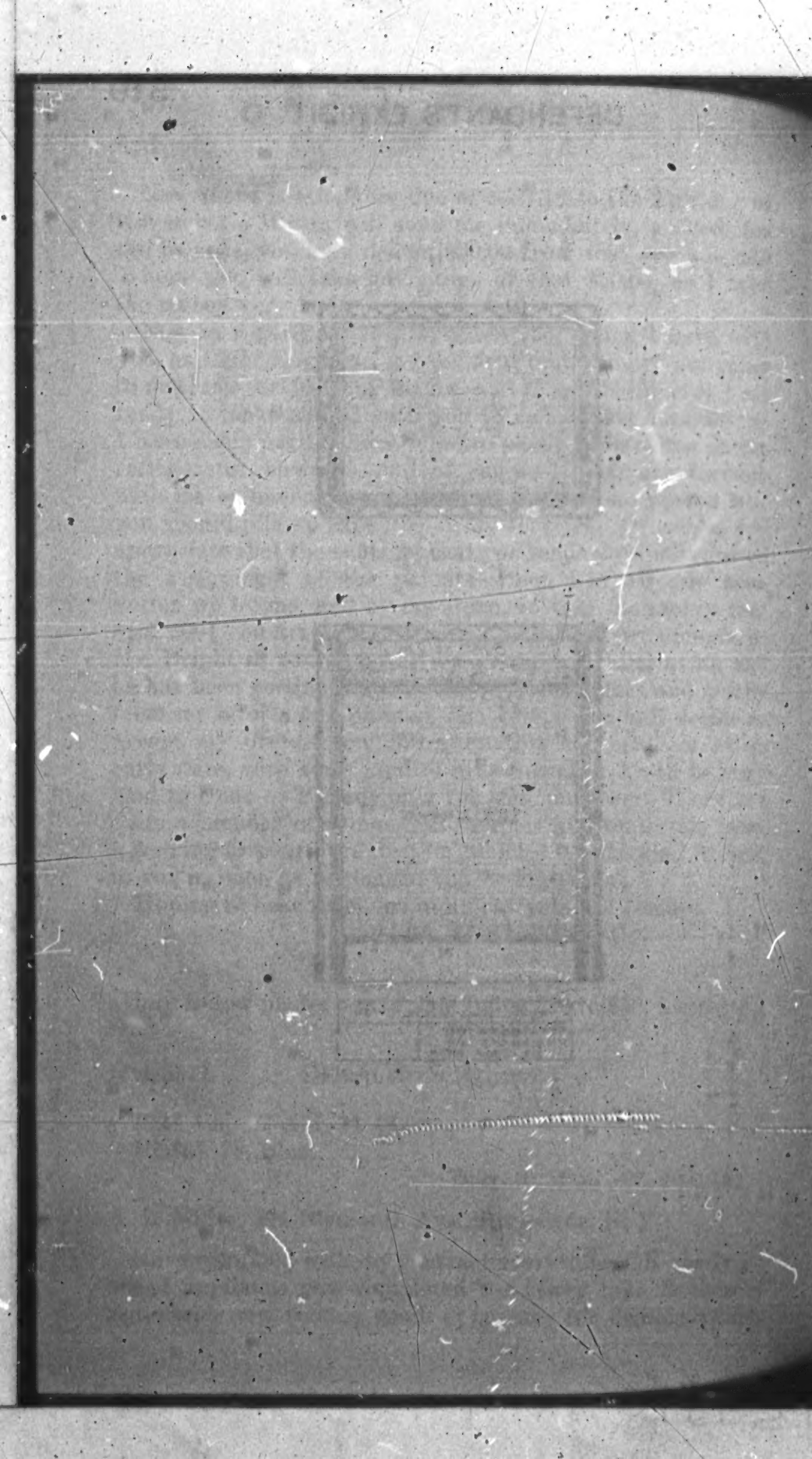
A. L. Miller, 594 Plymouth Ave., Rochester, N. Y.:

Have complied with my contract everything OK ready go ahead appliance now completed too heavy take Rochester Sorenseon now making small apparatus for demonstration

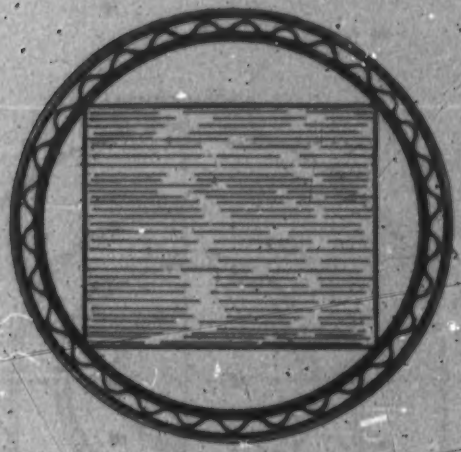
DEFENDANT'S EXHIBIT



TRADE	SMALL SIZE	6-15-24
REFRIGERATOR PRODUCTS CO. DETROIT MICH.		

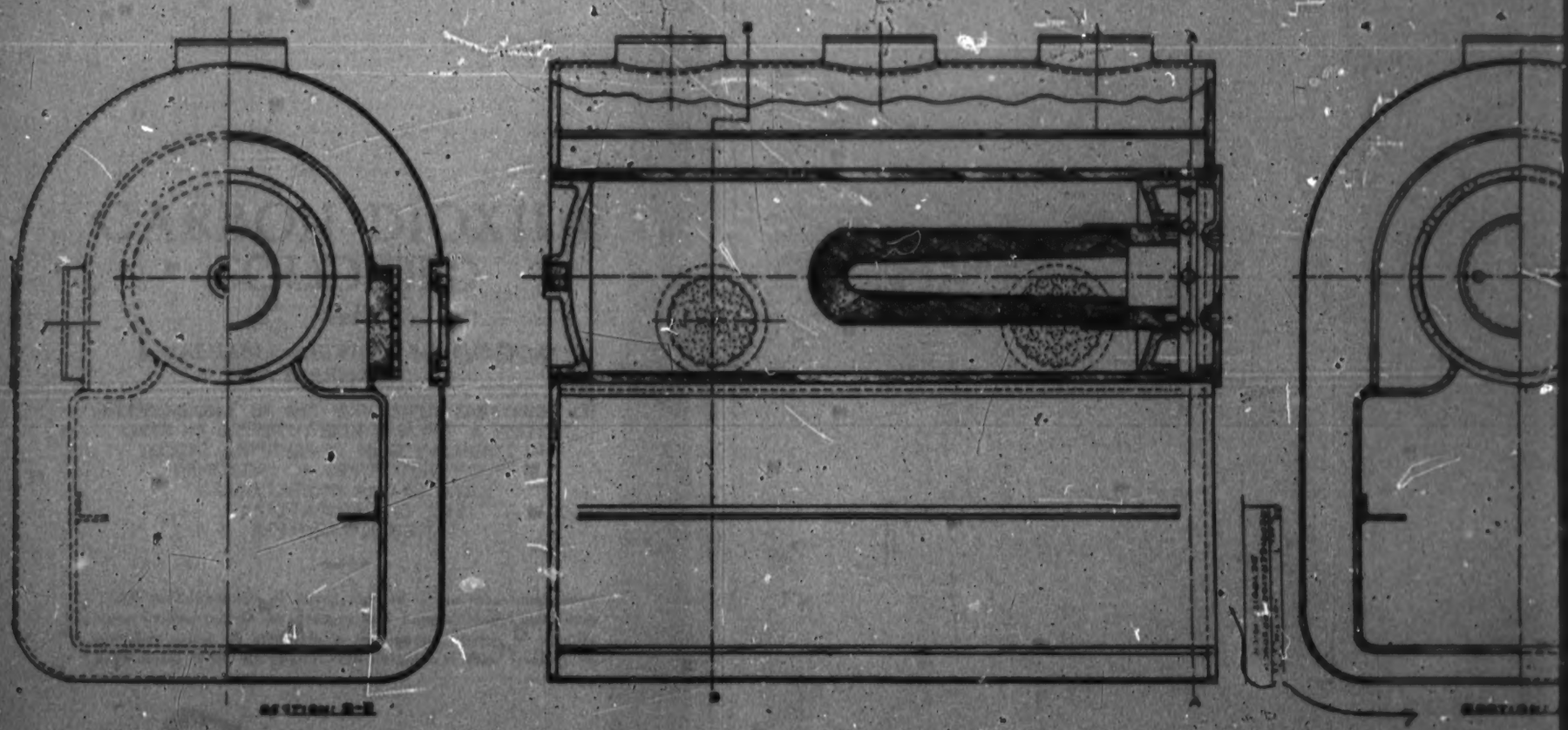


DEFENDANT'S EXHIBIT P 511



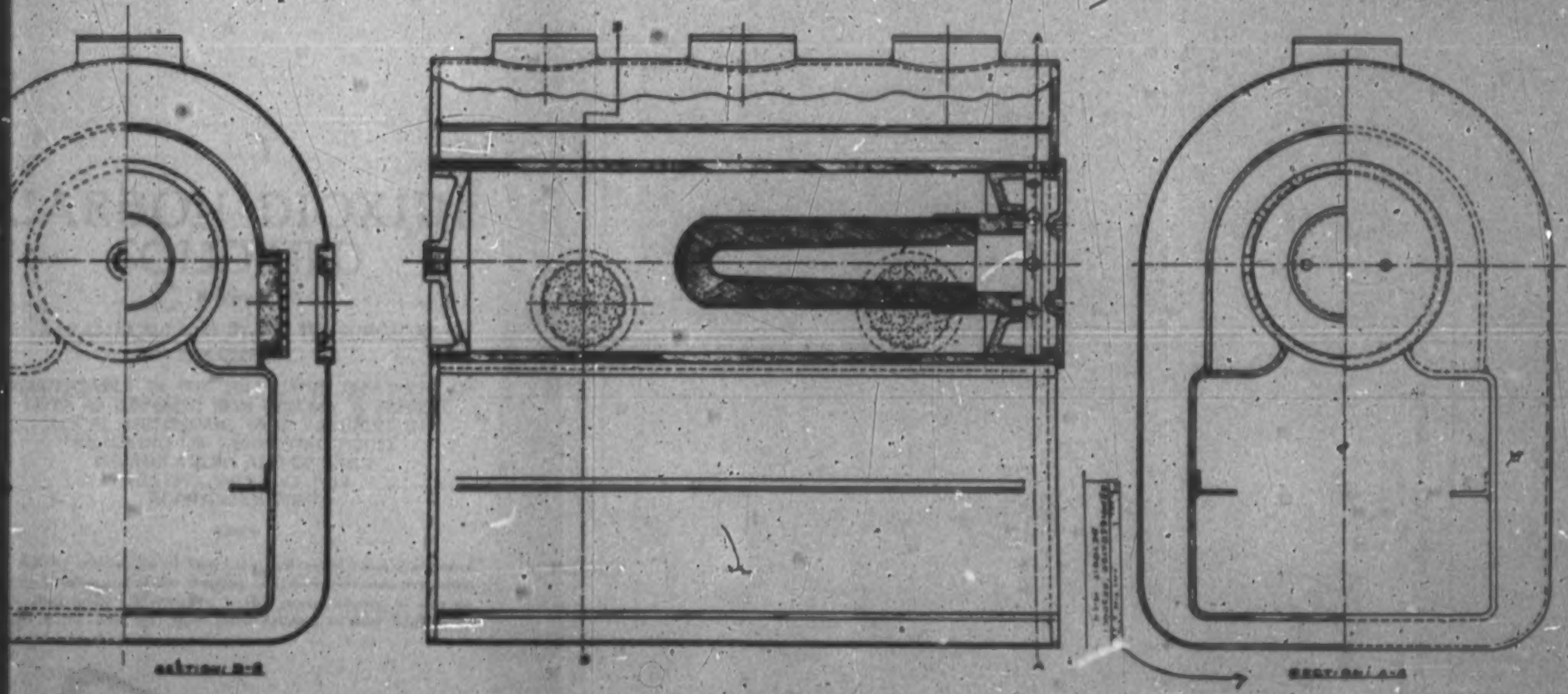
REFRIGERATOR
PRODUCTS CO

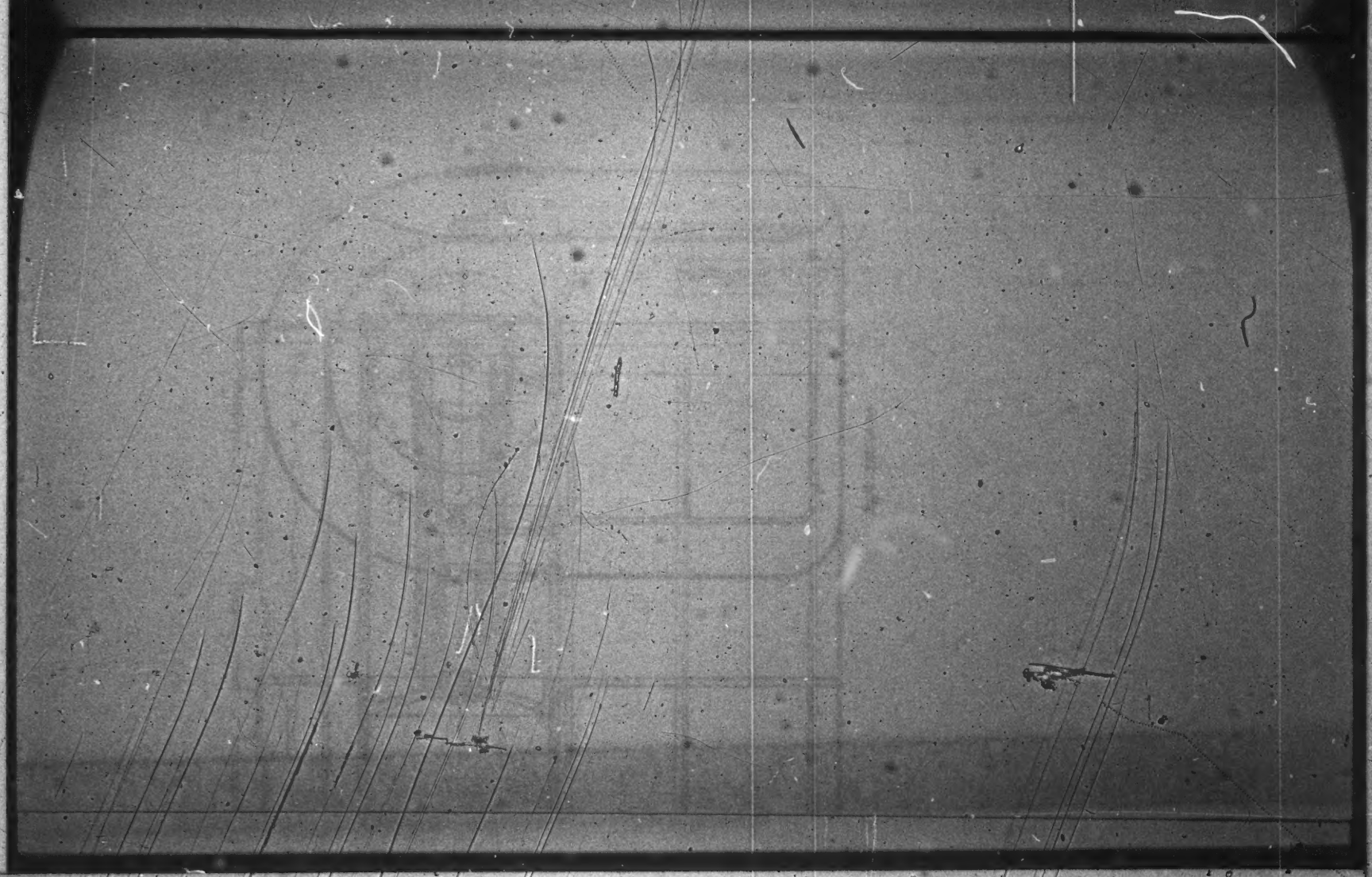
DEFENDAN



512

DEFENDANT'S EXHIBIT R





DEFENDANT'S EXHIBIT 8 513

CARBON DIOXIDE SOLIDIFIED

A VALUABLE ADDITION TO SURGICAL EQUIPMENT.

INDISPENSABLE IN THE SUCCESSFUL TREATMENT OF OVER 40 DIFFERENT SKIN LESIONS. A PERFECT LOCAL ANESTHESTIC. MOST VALUABLE IN REMOVING OR DESTROYING POUTY GRANULATIONS AND OF DAILY ASSISTANCE TO THE ROENTGENOLOGIST.

All the advantages of liquid air and every other destructive agent without any of the dangers and uncompressible difficulties attending many. A stimulant to the prompt closing of wounds, particularly those that have been delayed in their healing by infection.

ALDA MANUFACTURING CO.

CITY HALL SQUARE BUILDING

CHICAGO, ILL.

Copyright 1915 by J. C. Geesaman

RECENT HISTORY

Ten years of successful CO_2 ice therapy, supported by a mass of clinical evidence and the enthusiastic reports of thousands of the foremost Physicians and Surgeons from all parts of the world have firmly established the fact of the decided superiority of this remedial substance over any other known means of destroying tissue.

Dr. A. Campbell White successfully used liquid air for the treatment of cutaneous disease in 1899, and to him is due the credit for the inauguration of the low temperature therapy.

Fig. 2—Naevi, darkly pigmented hairy type, before freezing

The advanced and perfected treatment by means of this method was demonstrated before the Dermatological Congress in New York by Dr. Dade in 1905, which inspired Dr. W. A. Pusey of Chicago to suggest the use of CO_2 snow in order to eliminate the difficulties connected with the use and handling of liquid air.

Dr. Julius Berger of Breslau, Germany, likewise introduced carbon dioxide in 1905 as the only effective means of treatment by refrigeration in cases of trichomycosis, skin tuberculosis and ulcers of the leg, applying the evaporating CO_2 directly upon the diseased part with an apparatus invented and perfected by him.

In 1909 Dr. Joseph Eisler exhibited before the Dermatologic section of the American Medical Association the complete cure of a

case of rodent ulcer of considerable extent, encircling the left ear and covering an area the size of the palm of the hand. The freezing in this case was done in one sitting. The ulcerated area dried up in a comparatively short time and at the end of ten weeks the entire area was covered by a delicate smooth scar. After many additional successful treatments and cures effected with solidified carbon dioxide, Dr. Zeisler proclaimed, in 1910, "Most notwithstanding very energetic freezing the final result, as far as the cosmetic condition of the skin is concerned, is always satisfactory, and the resulting scar, if it is permissible to speak of a scar, is perfectly

Fig. 3.—Same case, two months later

smooth. Indeed, it would be difficult to compare this method in this regard with any other known means of destroying tissue, either by electrolysis, escharotics, caustics or pure surgical means." This feature, as well as the comparative painlessness, the rapidity of the work, the avoidance of an open wound and consequent danger of infection, make solidified CO_2 easily the "*Most Exquisite and Safest of all Destructive Agents.*"

Dr. Ralph Bernstein of Philadelphia published his very interesting book "Solidified Carbon Dioxide," in 1912. This book contains 95 reading pages, is profusely illustrated and gives a complete review of the excellent results achieved in many cases treated in numerous prominent hospitals as well as in private practice. Many other contributions to the CO_2 freezing therapy appeared from time to time, to all of which the marvelous results obtained with very

little effort and practically no expense were vividly pointed out. Particular stress has been laid upon the important fact that CO_2 is procurable anywhere, its cheapness and the ease of producing as well as molding it into suitable shape.

All the investigators agreed that the results to be obtained depended on two factors, the duration of contact between the medium and the surface to be frozen, and the pressure exerted during the application. The pressure particularly is of the greatest importance which makes it absolutely necessary for successful work to convert the loose and brittle CO_2 snow into a firm and hard crayon. Only in this form will it be possible to localize its application upon fixed areas or small points. It is therefore logical not to speak of the "CO_2 snow" therapy, but of the "CO_2 ice" method instead.

ANCIENT HISTORY

Although carbonic acid gas has been used since the earliest times for therapeutical purposes, its history in medicine is comparatively little known. Dr. Achilles Rose, in his very valuable book, "Carbonic Acid in Medicine," published by Funk and Wagnalls in 1905 shows that CO_2 was considered a valuable therapeutic agent centuries before its properties and characteristics were known.

The healing properties of mineral springs attracted attention in the gray dawn of civilization and knowledge. Wounded Greek soldiers who fought with Telephus on the banks of the river Caicus restored their health in Agamemnon's spring near Smyrna. Herodotus states that a spring in the "country of the fish eaters" prolonged life, and history tells us that the priests of Aesculapius erected temples to the God of Medicine in the vicinity of mineral springs. Paracelsus (1493-1541) made use of carbonic acid for therapeutic purposes, calling it Spiritus Sylvester. John Baptiste Van Helmont (1577-1644) showed that this gas was contained in the mineral water of Spa and that it had therapeutical value. Friedrich Hoffmann (1660-1742) discovered some qualities of this gas contained in mineral springs and called it spiritus mineralis. Joseph Black (1727-1799) assumed that it consisted in solid form in alkalies and called it fixed air. He supposed that it was produced by the act of respiration but was unable to prove it. Joseph Priestly (1733-1800), the discoverer of oxygen, was led to study gases by watching the processes of fermentation in a brewery next to his house and in a paper on "different kinds of air" which he read in March, 1772, he proposed among other things to saturate water with carbonic acid gas, which has led to the creation of the mineral water industry.

Fig. 4.—Flowing natural CO_2 gas well, Saratoga Springs, N. Y.

Antoine Laurent Lavoisier (1743-1794) was the first to bring order into the chaos of the "various different kinds of air" that had been discovered, and created scientific chemistry by establishing a correct scientific chemical nomenclature. He accurately explained the process of combustion, gave oxygen its proper name, established the fact that carbonic acid is a compound of oxygen and carbon and opened the way for the understanding of processes in the organic and inorganic world by his discovery of the law of the conservation of matter. Unfortunately he lived during the dark days of the French revolution and because of the fact that he was the most prominent mind of his age, he was indicted on a flimsy excuse, condemned to death and guillotined on March 8, 1794, under the brutal regime of Robespierre and out of blind revenge on the part of the people because he had held high positions under the king.

In 1823 Faraday succeeded in liquefying and Thilorier, in 1835, in solidifying carbonic acid. Hey, Whitering, Percival, Dobson, Warren, Mackride, Ingenhouss, Beddoes, Henry, Lee,

Rutherar and White, during the second half of the 18th and the first part of the 19th century, all made systematic use of carbonic acid for therapeutical purposes.

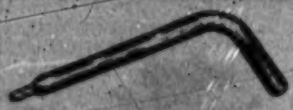


Fig. 3.—Faraday tube containing liquid CO_2.

Percival of Manchester found that carbonic acid had antiputrid properties and used it in cases of advanced phthisis as a palliative. It appears that he was one of the first who used it in cases of cancerous ulcer where it caused a disappearance of purulent matter, relieved pain and gave a better aspect to the wound surface. In non-malignant old ulcers of bad condition the gas produced excellent results. The pain was always relieved, the appearance of the wound markedly improved and in some cases a complete cure ensued.

John Ingenhousz discovered that carbonic acid had the remarkable property of quieting almost instantly even very severe pain, such, for instance, as is produced by vesication.

Some years after the publication of Percival's observations (May, 1772) French physicians began to employ carbonic acid in the treatment of cancerous ulcers and Follin wrote after Ewart had published the treatment of two cancerous ulcer cases in 1794 "that he had tried on some patients a new method of *local anæsthesia* which consisted in exposing ulcerated and painful surfaces to a continuous current of carbonic acid gas." P. J. L. Targioni of Florence reported the details of a case of cancer of the mamma treated by "fixed air"—carbonic acid. The gas had relieved the pain, corrected the bad character of the suppuration and improved the general condition of the patient. About one half of the cancerous ulcer had become cicatrised.

The Academy of Sciences and Art, of Dijon, and the Royal Society of Medicine, in Paris, both showed the beneficial effect of the gas on all kinds of ulcers and other affections. It was found and confirmed, that although carbonic acid gas did not cure cancer, it would relieve pain and act upon open ulcers in a beneficial way by modifying the secretion, producing to a certain extent cicatrization. Subsequently the anæsthetising and therapeutical effects of carbonic acid gas were used frequently by means of inflation and by the application of wet and dry carbonic acid gas baths, the history of which, methods of application and resultant outcome, have all been carefully compiled and chronologised up to recent dates by Dr. A. Rose.

CONCLUSION

The compellent logical deduction therefore is, that experimental cancerous, rodent and non-malignant ulcer cases, as well as many other afflictions, in which carbonic acid gas had been used with considerable success more than a century ago, but which did not completely yield to the treatment, will *respond to the more efficacious application of the solidified* CO_2, *which combines the beneficial action of the gas with the destruction of the diseased cell structure, thereby effecting a complete cure.* This conclusion has been fully substantiated by the results of the CO_2 ice "low temperature" therapy of the last 10 years.

LIQUID AIR AND ITS MANUFACTURE

Atmospheric air changes from the gaseous into the liquid state when its temperature is reduced to minus 220° F. and when it is at this temperature subjected to a pressure of 35 atmospheres. Its temperature of evaporation at atmospheric pressure is minus 312.6° F. When in the liquid condition it is light blue in color.

Faraday, Thilorier, Natterer, De la Tour, and, more recently, Pictet, Cailletet, Wroblewski, Olszewski, Dewar and others all have become famous in connection with their studies of the liquefaction of so-called permanent gases and also as a means of producing extremely low temperatures.

It will be readily seen that special means had to be employed to reduce the temperature of the air in order to make its liquefaction possible. Pictet and Cailletet used a succession of cooling agents, one cooling the next, and so on, until at last a temperature was reached low enough to liquefy it. These methods were expensive, however, so that for a long time the entire subject was confined to scientific studies only.

In May, 1895, Professor Carl Linde of Munich, Germany, exhibited before a body of physicists, chemists, and engineers his new method of self-intensifying refrigeration, by means of which gases, notably air, oxygen and nitrogen could be liquefied by a comparatively inexpensive method.

Linde dispenses entirely with the use of auxiliary refrigerants, but makes the gases themselves supply the refrigeration necessary for the reduction of their own temperature. He accomplishes this by the use of an ordinary compressor, exchanger, water cooler, expansion valve and liquid receiver. Professor Linde was the first

who clearly understood the physical principles underlying the operation and who gave numerical data regarding the efficiency of the cycle of operations involved therein.

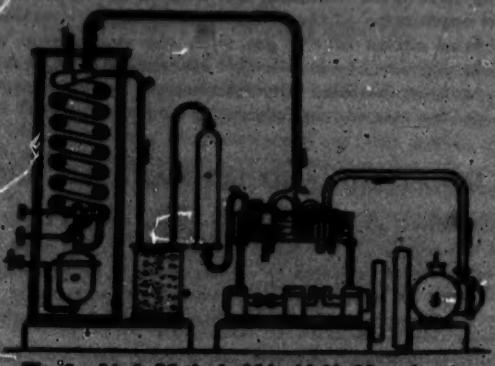


Fig. 6.—Linde Machine of Liquid Air Manufacturing

Liquid air cannot be retained in closed receptacles owing to its tremendous expansive power. It is ordinarily contained and shipped in Dewar's double tubes in which the air in the space between the tubes walls has been evacuated. The principle of the Dewar tube is employed in our customary Thermos bottles. In these tubes or receptacles the liquid air may be retained for some time owing to the slow exchange of heat through the vacuum, which forms an excellent insulator, and also to the fact that it preserves itself by partial evaporation until the last remnant has been used up in the preservation of the balance.

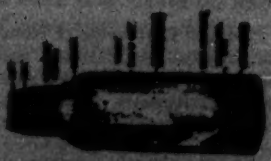


Fig. 7.—Thermos bottle for storage of CO_2 ice

It is thus clear that this substance cannot serve the purpose of the regular practitioner since it will evaporate and disappear between times. Moreover, it is not easily obtainable, is rather expensive and cannot be handled in the application with the same ease and firmness as carbon dioxide ice.

LIQUID CARBON DIOXIDE

The color of the liquid CO_2 is a yellowish-white. It may be conveniently liquefied and evaporated in a Faraday tube in which it is contained under pressure. Upon cooling the tube by allowing hydrant water to flow over it, the gas changes into a liquid of the above description, but as soon as it is exposed to heat, a violent ebullition takes place and a gas of dense, cloudy form appears, which becomes lighter and less dense in a short time. The specific gravity of the gas is 1.529; it is therefore 1.5 times heavier than air and will drop rapidly to the floor when liberated into the air.

In order to liquefy this gas at atmospheric pressure it would be necessary to reduce its temperature to —134° F. and since that is not practical, liquefaction is accomplished under pressure and subsequent cooling of the gas. The pressure reduces the volume of the gas and since the work of compression is changed into heat it becomes possible to absorb the heat of the compressed gas as well as its latent heat by ordinary cooling water. During the summer months when most of the liquid carbonic acid is made and used and when the average temperature of the cooling water is from 70° to 75° F. a pressure of over 70 atmospheres is required to liquefy the gas and force it into the commercial containers or cylinders in which it is delivered upon the market.

Carbon dioxide is a product of the oxidation of carbon in any form and yields a most important influence in the realm of nature. It changes the carbonates of the metals and of the alkali earth into bi-carbonates in which form they become soluble in water. It supports the vegetable kingdom and through it the animal world, but at the moment of extinction of life the organic matter is destroyed and separated into the original elementary substances of water, ammonia and carbonic acid, which are then again introduced into the creative and regenerative cycle of life to perform the same work over again.

Lavoisier was the first to recognize the composition of carbonic acid clearly and in 1780 he gave it the chemical symbol CO_2 by which it has since been known.

Liquid CO_2 is commercially produced by the combustion of coke during which two molecules of oxygen are chemically combined with one molecule of carbon and in this form it is a part of the combustion or flue gases. These gases are then forced through a washing process and thereafter through an absorption tower wherein a shower of soda or potash lye absorbs the CO_2 gas from the rest of

the combustion products and broadly blends it with its own atmosphere. The lye saturated with CO_2 in form absorbed constituents is then subjected to a heating process in a closed receptacle, the pure CO_2 gas is driven from the lye and collected in a gasometer. It is now ready to be liquefied by the compression process and in order that this procedure may be carried out with the necessary economy, compressors of the multiple type are employed, that is, the machine has a number of comparatively small cylinders in which the gas is compressed from atmospheric to liquefying pressures by stages. It is then forced into the condenser to be liquefied. After liquefaction it is weighed into the steel cylinders in which it is delivered to the consumer. A diagram comprising the Greenstreet system of CO_2 manufacture shows the various devices involved and the successive stages through which the gas passes from the combustion in a furnace, under the boiler, or in a lime kiln as shown, to the final filling apparatus.

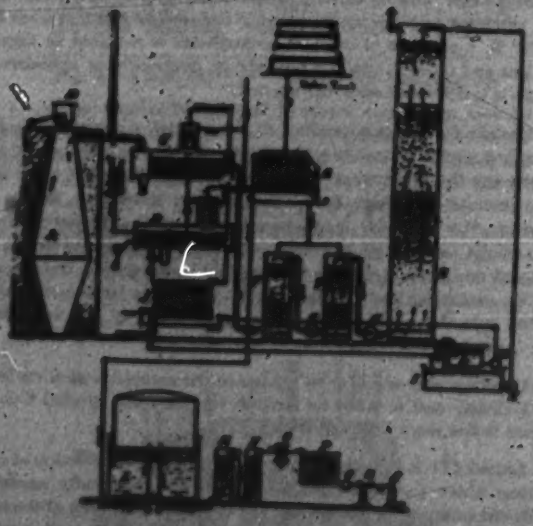


Fig. 2.—Greenstreet System of Liquid CO_2 Manufacture

CO_2 may also be obtained in the manufacture of calcined and sublimed lime as a by-product or in a brewery where large quantities of CO_2 are generated during the process of fermentation.

LIQUID CO_2 CONTAINERS

The steel containers in which the liquid CO_2 is delivered consist of a seamless drawn tube with welded top and bottom. Each tube must be periodically tested by U. S. inspectors. The test pressure is 3500 lbs. The practical pressure of gas in these tubes is 1000 lbs., which leaves a sufficient margin of safety. Each cylinder valve is provided with a safety disk which breaks at 1500 lbs. of pressure, so that a positive means of relieving unduly high pressure caused by the exposure of the filled cylinder to sun, or other external heat, is provided in a simple way. It follows that these cylinders may be handled without danger or risk to the user.

Cylinders may be made to contain varying weights of liquid CO_2. A small cylinder for office use contains 5 lbs. of the gas. This cylinder is 4½ inches in diameter and 24 inches long. Its weight is 16 lbs. empty and 22 lbs. when filled.

Fig. 9.—Small office cylinder in collapsible table stand

The customary commercial cylinder containing 20 lbs. of liquid CO_2 is 5½ inches in diameter and 4 feet 2 inches long without the valve, and 4 feet 6½ inches with it. Its weight empty is 70 lbs. and when filled 90 lbs.

The largest size of cylinder in commercial use has a liquid CO_2 capacity of 50 lbs. It is 8½ inches in diameter and 4 feet 3 inches long without the valve and 4 feet 8 inches with it. Its weight empty is 180 lbs. and filled 150 lbs.

THE ACTION OF CARBON DIOXIDE ICE UPON THE SKIN AND TISSUE

The immediate effect of solidified carbon dioxide in the treatment of cutaneous disease is thrombosis, injury to the cells of the tissue and inflammatory reaction. With the occurrence of thrombosis there is a gradual shutting off of the blood supply to the area treated. Naturally this must follow the injury to which the blood vessel walls are subjected after freezing takes place. The production of thrombosis is a gradual one. In their beginning they appear to be finely granular in nature, and later on there seems to be co-associated the formation of leucocytic thrombosis. In addition, a rather clear hyaline-like material appears.

There is no doubt that the tissues and blood vessels naturally undergo a decided injury during the freezing, which has been explained as due to the fact that during the freezing of the liquid matter in each cell the bursting of the cellular structure is accomplished on account of the expansion of this matter during the change from the liquid into the frozen state.

Fig. 18.—CO_2 ice pencil, ½ in. x 3 in.

The freezing also sets up an intense inflammatory reaction, which in turn stimulates the tissues and cells to react in pouring out free exudation of lymph and leucocytes; the former acting as a continual flusher of the diseased area, and the latter assisting in the removal of the products of inflammation.

It has always been observed that the CO_2 treatment exercises a wonderfully friendly influence during the healing process, especially in wounds which have been cauterized with it.

SUPERIORITY OF CO_2 ICE THERAPY

The results of ten years of experience with the CO_2 ice therapy have developed the startling fact that there has been absolutely no tendency towards return in the many thousands of cases of all types treated, which distinguishes this method very favorably from any other, be it the X-ray, radium, light, escharotics therapy or plain surgical methods.

In its rapidity, as well as in its results, it is without a competitor.

It is equally certain that it is absolutely devoid of danger.

Among the chemical substances which have been recommended from time to time, the most successful known as "Thereneddin" has less than 50% of cures in its favor, while the CO_2 ice therapy covering the same field is credited with over 98% cures.

This fact proclaims louder than any words could do the unchallenged and unrivaled superiority of CO_2 ice *as the remedy par excellence in the successful treatment of cutaneous neoplasms.*

The action of carbon dioxide ice can be absolutely regulated, so that there is never at any time a question as to whether the curative base of the neoplasm has been reached or not.

Fig. 11.—Correct method of application.

The cosmetic results achieved are always beautiful in the end. The adnexal epithelial covering which may appear whiter than the surrounding skin at first, assumes a pinkish hue later on and finally the color of the normal epidermis.

Pain is practically absent, the patient being frequently unable to determine whether the sensation is one of heat or of cold. A

stinging sensation is usually experienced after the frozen area has thawed out, which, however, lasts only a few minutes. Lesions treated upon the temporal regions and the lips are more painful that areas treated elsewhere. Smaller lesions are usually without pain after treatment, and only those which involve larger areas and deeper structures are more or less co-associated with pain.

SUMMARY

CO_2 ice can be readily made and molded. It is inexpensive, each crayon costing only a few cents. All areas as well as cavities are accessible to it. Thorough control admits superficial as well a deep freezing.

OTHER ADVANTAGES ARE:

Short duration of treatment.
Practical absence of pain.
Ability to reach areas beyond involvement.
Absence of danger.
Lack of violent reaction.
Cosmetic results are always pleasing.
Absence of tendency to degeneration.

RANGE OF USEFULNESS

The CO_2 ice therapy is successfully used in the treatment and cure of over 40 different lesions and afflictions, which have been classified by Dr. Kornstein together with the time and pressure of the freezing applications as follows:

ACNE PUSTULOSA	Time	5-10 seconds	pressure	light
ACNE INDURATA	"	10-15 "	"	medium
ACNE KELOID	"	15-20 "	"	heavy
ADENOMA SEBACEUM	"	10-15 "	"	light
ALOPECIA AREATA	"	10-30 "	"	light
ANGIOMA NAEVUS VASCULOSUS	"	10-30 "	"	light
ANGIOMA TELAN-GIECTASIS	"	30-50 "	"	medium
ANGIOMA CAVER-NOUS	"	30-50 "	"	heavy
ANGIOKERATOMA	"	30 "	"	heavy
CALLOSITAS	"	60 "	"	heavy
CARBUNCLE	"	30-50 "	"	medium
CHLOASMA	"	10-20 "	"	light
CLAVUS	"	60 "	"	heavy
COLLOID DEGENERA-TION OF THE SKIN	"	30 "	"	medium
CORNU CUTANEUM	"	30 "	"	medium
DERMATITIS REPENS	"	30 "	"	medium
ECZEMA	"	5-30 "	"	medium
EPITHELIOMA ULCERO HYPERTROPHIC	"	30-60 "	"	heavy
EPITHELIOMA SUPER-FICIAL	"	30-60 "	"	heavy

EPITHELIOMA CYSTIC BENIGN	Time: 30-60 seconds; pressure medium			
EPITHELIOMA EXUBERANT GRANULATING	"	30-60	"	"	heavy
EPITHELIOMA ULCERATING	"	30-60	"	"	heavy
EPITHELIOMA RODENT ULCER	"	30-60	"	"	energetic
ERYSIPELAS	"	10-15	"	"	medium
ERYTHEMA PERNIO	"	5-10	"	"	light
FOLLICULITIS DECALVANS	"	30	"	"	heavy
FURNUCULOSIS	"	30-60	"	"	medium
HYDROCYSTOMA	"	15	"	"	medium
KELOID	"	60	"	"	heavy
KERATOSIS FOLLICULARIS	"	30	"	"	medium
LENTIGO	"	10	"	"	light
LEPROSY	"	30-60	"	"	heavy
LEUKOPLAKIA	"	10	"	"	medium
LICHEN PLANUS	"	30	"	"	heavy
LUPUS ERYTHEMATOSUS	"	30-60	"	"	medium
LUPUS VULGARIS	"	45-60	"	"	medium
LYMPHANGIOMA	"	45	"	"	heavy
MILIUM	"	10	"	"	medium
MOLLUSCUM CONTAGIOSUM	"	30-60	"	"	heavy
MORPHEA	"	15	"	"	light
NAEVUS PIGMENTOSUS	"	10	"	"	light
NAEVUS PILOSUS	"	15	"	"	medium
NAEVUS VERRUCOSUS	"	30	"	"	heavy
NAEVUS LIPOMATODES	"	45	"	"	heavy
PAGET'S DISEASE	"	60	"	"	heavy
POWDER STAINS	"		"	"	heavy
PSORIASIS	"	10-15	"	"	medium
RODENT ULCER	"	60-60	"	"	energetic
ROSACEA	"	15-30	"	"	medium
SEBORRHOEA	"	30-45	"	"	medium
STEATOMA	"	30-60	"	"	heavy
TATTOO MARKS	"	60 and over		"	energetic
TUBERCULOSIS CUTIS	"	45-60 seconds;		"	heavy
TUBERCULOSIS VARRUCOSA	"	45-60	"	"	heavy
TUBERCULOSIS SCROFULODERMA	"	45-60	"	"	heavy
ULCER	"	15	"	"	medium
VERRUCA VULGARIS	"	45-60	"	"	heavy
VERRUCA PLANA	"	45-60	"	"	heavy
VERRUCA FILIFORMIS	"	45-60	"	"	heavy

XANTHOMA PLANUM	Time 30-45 seconds; pressure medium			
XANTHOMA TUBEROSUM	" 45-60	"	"	heavy
XERODERMA PIGMENTOSUM	" 20-30	"	"	medium
X-RAY KERATOSES	" 45-60	"	"	medium

PAINLESS LOCAL ANESTHESIA AND CURETTMENT

The anesthetic properties of CO_2 ice are very often preferable to ethyl chloride or ether spray and more frequently to cocaine or other injection, of which particularly the latter is by no means painless, while often unsatisfactory in its effects.

CO_2 ice as an anesthetic agent is of course limited to surface condition in which it is necessary to incise the skin. This, of course, covers deeper lying lesions requiring incision. If the incision is small, not exceeding half an inch in length, the anesthetic effect is quickly and painlessly procured by using the full size end of an ice crayon, which is about one-half of an inch in diameter.

Fig. 12.—Exuberant granulating type of epithelioma unusually resistant to all types of previous treatment

The duration of the application should be about three to five seconds and medium pressure should govern the application. If the required incision is longer, say two or three inches, it is advisable to draw a surface line and follow this line with the end of the crayon and a two- to five-second medium pressure of application at each point of contact. Should the diameter of the crayon cover an area

larger than required it may be reduced to a rectangular form either by cutting with a knife or by melting it into the desired shape through contact with a flat metallic surface which melts down the sides of the CO_2 ice crayon rapidly.

This technique will provide a degree of anesthesia which will make the incision entirely painless.

In cases requiring curettement after the incision, such as in carbuncles or other infected lesions, quite a satisfactory degree of local anesthesia may be obtained deeply in the wound by inserting the crayon, after properly moulding it, so that thorough curetting can be done with little or no pain.

In cases of old, neglected and ulcerated sores the same procedure has given splendid results.

It is an easy matter to guard against a too extreme effect by short freezing contacts which allow close observation. It has also been observed that the CO_2 ice application stimulates the healing process through the peculiarly beneficial influence of CO_2 upon the skin-building faculty of the tissue.

The practice should be to freeze from point to point before and even during the curetting rather than freezing too deep at once, for it is easy enough if the patient complains, to make an additional light freezing application to insure satisfactory anesthesia.

It may be mentioned, however, that deep freezing has in no case led to complication or untoward effect; it merely effected tissue deeper than necessary. See also chapter under "Maximum CO_2 Ice Crayon Instrument, Type 3."

FOUTY GRANULATIONS

One of the most common impediments to normal repair in wounds, particularly such wounds as have passed through a period of infectious inflammation, is, what has been termed, exuberant or proud granulations, also and more commonly known as proud flesh.

A number of means of removing or destroying this overgrowth of granulation tissue have been adopted; these are cauterizing chemicals, the curette, or clipping off with scissors.

The use of chemicals is slow and instrumental removal is, as above, accompanied by profuse hemorrhage. Cauterization is open to the same objection; moreover a sensitive patient is usually inclined to shrink from instrumental interference with a wound in this condition. The most satisfactory method is the use of the CO_2 ice crayon.

When a CO_2 ice crayon is brought into contact with a granulating surface, it causes immediate shrinking to the level of or even below the adjacent skin surface, and the clean crust which follows the application serves as a barrier to the further exuberant proliferation of the granulating surface, allowing the new skin to progress in its proliferation toward the closing of the wound.

The advantages of this method are several. First—it is entirely without objection to the patient; second—it is bloodless, and last as well as most important—it accomplishes immediate destruction of the proliferating tissue, seldom requiring more than one or two applications in wounds of small size.

Fig. 13.—Same case twelve weeks after treatment, leaving smooth, whitish scar with normal epithelial covering

The same treatment may be applied to chronic ulcerating surfaces and particularly to varicose ulcers, in which epithelization is prevented by the indolent overgrowth of the granulating surface of the ulcer. It has also been noticed that the stimulation resulting from the application of CO_2 as above suggested has a decidedly beneficial effect in inducing more prompt closing in of wounds that have been delayed in their healing by infection. Occasionally cases are encountered in which considerable pain is experienced during the application of the crayon, but the duration is not long and not sufficiently severe to constitute an objection. As a rule and in a majority of cases no pain is felt at all.

The duration of the application should be governed by the extent of the overgrowth, in all ordinary cases a freezing contact of from 5 to 10 seconds is sufficient and the pressure does not exceed a light caress.

REMOVAL OF SUPERFICIAL OVERGROWTHS BEFORE RAYING

If the choice were always left to the physician probably many cases of epithelioma and other malignant and benign affections of the skin and mucous cavities that come under his care as an X-rayist, would be subjected to the knife before they are rayed. But the dread of the knife on the part of many patients prevents this combination of surgery and radiotherapy with the result that much raying must be done in the course of the work that might otherwise be avoided.

Any means that will accomplish practically the same end as is effected by the surgical removal of tumor masses and convenient proliferations, and which, at the same time, arouses not the slightest fear on the part of the most shrinking patient, will without doubt be heartily welcomed by the X-rayist. For such an auxiliary in his work means not only the saving of much time both for doctor and patient, but considerable in tube life and efficiency as well.

This end is readily obtained by the use of solidified CO_2 reduced to the form of a convenient crayon having the extremely low temperature of 110 degrees below zero. In this form CO_2 offers to the dermatologist and X-rayist the best destructive agent of proliferant tissue known to science. A ten or twenty-second application of CO_2 ice will accomplish as much in the removal of superficial overgrowths and ulcerative masses, as would many weeks of intensive raying, and in many cases this short-cut will not interfere with the immediate continuance of the use of the *ray for its effect on the deeper lying tissues.*

Certain cases which show an early intolerance to an energetic application of X-rays can be reduced to the point of easy tolerance by leaving to the ray only the buried structures while destroying the entire overgrowth by means of CO_2 ice.

The CO_2 ice therapy is the most effective assistant to the Roentgenologist, it lightens his work and produces the desired end results much more rapidly and more thoroughly satisfactory.

THE PRODUCTION OF A CO_2 ICE CRAYON

Before the invention of the Gassmann Carbon Dioxide Ice Crayon instrument, CO_2 snow was obtained in a very crude way by evaporating the liquid CO_2 through a bag made of chamois leather. The CO_2 snow which collected in the bag was then pounded into shape and whittled down to convenient size with a knife.

But in spite of all the labor and time spent, together with a prodigous waste of gas to produce it in a semi-solid form it served its purpose but imperfectly because it still was a snow and too brittle in substance to permit the necessary pressure during the application or allow the sharply localized treatment of fixed areas and cavities.

GOODMANN CO_2 ICE CRAYON INSTRUMENT TYPE 1.

The first instrument which actually produced a CO_2 crayon compressed into the solid and translucent form of CO_2 ice was invented by J. C. Goodmann in 1909 and patented in January, 1910. Thousands of these instruments, known as piston instrument Type 1, are today in the hands of noted physicians and surgeons scattered over the entire globe.

With this instrument is usually furnished a small CO_2 cylinder containing 6 lbs. of liquid CO_2 supported upon a stand as shown in illustration Fig. 22.

Fig. 16.—Sectional view of crayon instrument, type 1

The piston instrument type 1, shown in longitudinal section, Fig. 16, consists of a perforated cylinder which is closed on one end with a cap and on the other with a piston rod flange through which the threaded piston rod travels. The perforation of the cylinder is covered with a wrapper held in place by a perforated sleeve. A hard rubber insulator, also perforated, fits over the sleeve and is held in place by a flange ring which rides upon the threaded cylinder.

With the instrument is furnished a steel nickel plated spanner key, a nickel plated piston bar for the operation of the piston as well as for opening and closing the valve of the small CO_2 cylinder and a metallic shield for the purpose of forming a point at the end of the CO_2 ice crayon.

A special valve key will be found attached to the cylinder valve. This key fits the square of the valve stem and provides the best means to open and close the valve a fraction of a turn.

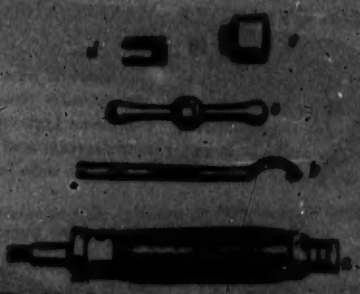


Fig. 15.—Instrument, type I, and parts

The instrument fits the thread of the valve nipple of the small tank, but if it is desired to use it in connection with a large commercial CO_2 cylinder, a reducing fitting must be placed between the cylinder valve and the instrument, which fitting is furnished with each apparatus.

Fig. 16.—Instrument and parts in steel leather case

The instrument with its accessories is placed in the corresponding recesses of a steel leather case as shown in the illustration Fig. 16.

CO₂ CYLINDER, VALVE AND SUPPORT

Liquid carbonic acid may be obtained in any locality in commercial cylinders containing 20 lbs. of the liquid. A charge will be made for the gas only, while the cylinder remains the property of the CO_2 gas manufacturer. This same type of cylinder and gas is handled by every soda water manufacturer and is used in practically every drug store in connection with the soda fountain.

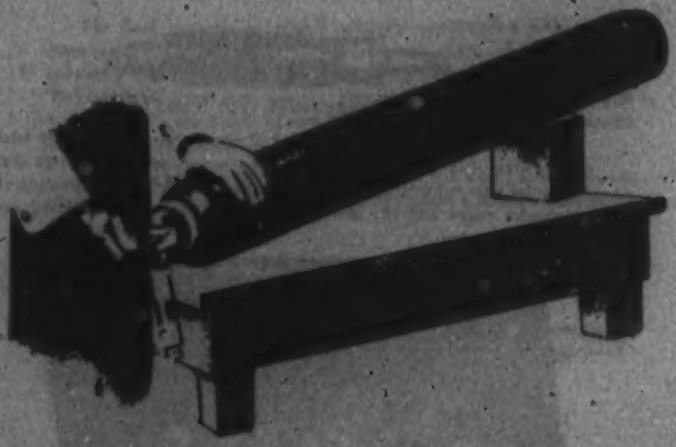


Fig. 17.—Commercial CO_2 cylinder placed on a table

When this cylinder is used, it must be placed in a declined position with its valve end at the lower point as shown in illustration Fig. 17, or it may be placed in floor stands as per illustration Fig. 18.

It is absolutely essential to tilt the cylinder in order to obtain the gas in its moist or semi-liquid form at the valve, as only the wet gas will crystallize, while the dry gas will seek the highest space within the cylinder owing to its lighter specific weight.

A cylinder placed vertically with the valve end up will not form one crystal of snow.

The valve of the cylinder should be thoroughly tried at first in order that the operator's hand may become accustomed to its action; that is to say, whether it works easily or hard.

Fig. 18.—Commercial CO_2 cylinder in floor stands with evaporating valve and crayon instrument.

Having become acquainted with the action of the controlling valve of the cylinder, it is well to become thoroughly familiar with all the parts of the instrument. The piston and its flange may be easily removed by unscrewing it from the cylinder part. A spanner key serves to fasten and unfasten the apparatus from the CO_2 cylinder valve and also to hold the instrument firmly on the table while compressing the snow as shown in Fig. 19. A solid piston bar, having a square hole, fits the piston rod as well as the valve stem of the small office cylinder. It serves for the compression of the snow as well as for opening and closing of the valve. The small round mold has a tapered opening used for pointing the CO_2 ice crayon when lesions of small area are to be treated.

DIRECTIONS FOR MAKING A CO_2 ICE CRAYON

The procedure now is as follows: Attach the reducing fitting to the nipple of the cylinder valve when using the large cylinder. This fitting is not needed when the small cylinder is used as the crayon former fits directly upon the nipple. Remove the piston with the flange from the instrument and place it fairly tight upon the cylinder valve. Next open the cylinder valve, slowly at first, allowing a little carbon dioxide to evaporate freely through the

Fig. 19.—Compressing CO_2 snow into ice.

instrument, but without force and sputtering noise. It is advisable to slowly open and close the valve while the liquid is evaporating through the instrument. In about one minute after beginning the evaporation of the CO_2 frost will appear on the outside of the instrument. This will slowly creep over on to the hard rubber insulator, indicating that the instrument is sufficiently filled. When the instrument is entirely filled with crystals and more CO_2 is trying to crowd in from the cylinder, pressure develops and some of the crystals will be blown through the perforations with considerable force. In this case the cylinder valve should be closed immediately. Next remove the instrument and insert the piston into the same; secure it by means of the piston flange, place the instrument in the grip of the spanner key and put it firmly down on the table, as shown in Fig. 19, which allows the compression of the crystals by means of the screw piston and handle bar into a solid and firm ice crayon.

Fig. 20.—Moulding and shaping CO_2 ice pencil

After thorough compression remove the cap from the outlet end of the instrument and force out the crayon by turning the piston until it has been discharged. The crayon can then be handled with a piece of chamois as shown in Fig. 20, or with rubber gloves. The same illustration shows the method of molding a point on the end of the crayon. The metallic shield will get very cold during this procedure and the shaping may be greatly facilitated by dipping it into warm water from time to time. The end of the crayon can be formed into a square by pressing its sides against a flat piece of metal. In this way any desired contour of the CO_2 ice may be readily produced.

SPECIAL EVAPORATING VALVE ATTACHED TO CYLINDER VALVE

It will often be found that the valve of the commercial cylinder does not readily adjust the flow of gas. This is due to the fact that it is of the flat seat design and intended merely as a stop valve. It is, however, necessary to perfectly control the flow of gas issuing through the valve and we have therefore found it expedient to use the cylinder valve for the purpose of which it is intended, i. e., for opening and closing only, and attach to it a special evaporating valve by means of which the flow of gas can be thoroughly and easily regulated, similar to the valve which is often connected between a cylinder of liquid CO_2 and a freezing microtome.

This valve is illustrated in Fig. 21. It is of the needle point type and provided with a handle which facilitates easy adjustment. One end of the valve is provided with a square slip-nut connection and threaded with a standard ⅛-inch pipe thread which fits the nipple of any commercial carbonic acid cylinder in every country.

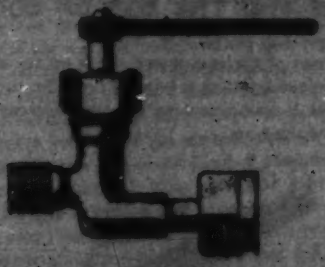


Fig. 21.—Special evaporating valve.

Before fastening the valve, place the two fibre washers, which will be found tied to the valve, into the slip-nut and fasten tightly upon the cylinder valve nipple with a monkey wrench, making sure that the regulating valve is in the position most convenient for operating.

The connection so made must be gas tight under pressure. Try it by closing the regulating valve and opening the cylinder stop valve at least a quarter turn.

The instrument is then attached to the threaded nipple and the crystals will be readily produced by proper adjustment and regulation with this valve.

Of equal importance is the proper position of the commercial cylinder. It must be placed horizontally, slightly depressed with the valve at the lowest point to insure a flow of wet gas. With the outlet valve at a higher elevation only dry gas will issue therefrom which cannot produce snow crystals as will be obvious.

OBJECTION TO THE COMMERCIAL CYLINDER

The principal objection to the large cylinder is its weight and its rather clumsy appearance as an office equipment. For this reason the more elegant equipment shown in Fig. 22 has met with general favor by the profession. It is extremely neat in appearance, light in weight, takes up little space and is very convenient in producing a CO_2 ice pencil.

The container is easily handled as its gross weight does not exceed 30 lbs. The valve has been especially designed and as it is of the needle point type, it is most suitable for the evaporation of the liquid CO_2. The cylinder rest of the stand is adjustable and can be set at any angle; however, in this case as well as in that of the large cylinder the degree of elevation does not need to exceed that shown in the illustration.

Should the available office space prevent the use of the stand, a collapsible table stand shown in Fig. 9 may be used instead.

DIRECTIONS FOR THE USE OF EQUIPMENT TYPE I.

Upon the receipt of the equipment check up the separate parts and make sure that everything is in good order for use.

The stand has a clamping handle which fastens the cylinder loop in the desired position.

Fig. 1—CO_2 office cylinder and stand

A scale attached to the cylinder shows its weight when filled and when empty, also the net weight of liquid CO_2 contained therein.

Place the cylinder in the loop and fasten securely. The valve nipple should then be in a position pointing sideways, while the right hand is used for the adjustment of the valve as shown in Fig. 27.

After making sure that the instrument is provided with all the parts shown in Fig. 15, remove the piston from the instrument. It will now fit the thread of the valve nipple. Run it up on this thread by hand. The spanner wrench is hardly ever needed for this movement.

Having previously tried the cylinder valve to see how far it needs to be opened to obtain a white looking stream of gas, open the valve as before and allow the gas to pass into the instrument.

Part of the gas will pass through the instrument and escape through the perforations in the insulator. This is necessary to produce the required low temperature in the instrument. The balance of the wet CO_2 molecules are then crystallized similar to the crystallization of the wet vapors into snow in the frigid atmosphere.

Care should be exercised not to allow the gas to escape through the instrument with too much force; while there is no danger when too great a volume of gas crowds through the instrument, it will blow the crystals just formed out of the instrument and the pencil after compression will show irregular channels or holes through which the gas forced its way under pressure.

An easy flow of gas produces the best results.

The metallic parts of the instrument will show frost very shortly and in about a minute the hard rubber insulator next to the metal will become white.

This indicates that the instrument is now very cold and that it is filled with CO_2 snow.

The valve may now be shut tightly and the instrument removed therefrom. A glance into the instrument will show whether or not it is sufficiently filled. If it is less than half full, it may be placed back on the valve and the manipulation repeated until sufficient snow has been collected.

These snow crystals must now be compressed into a solid pencil, which is done by inserting the piston into the instrument and employing the pressure of the piston screw as explained on page 23 and shown in Fig. 18.

The CO_2 pencil or crayon is now ready for use. If it has been made previous to the arrival of the patient it may be kept in a small thermos bottle for several hours.

Caution: Be sure the cylinder valve is closed tightly.

GOOSMANN CO_2 ICE CRAYON INSTRUMENT TYPE 2.

The crayon instrument type 2, is similar to type 1 in all its essential parts, except in the method of compressing the CO_2 snow, which is accomplished in this case by means of a rod and a hammer or mallet.

Fig. 23.—CO_2 ice crayon instrument—type 2

The interior construction consists of two perforated metallic sleeves and a wrapper placed between the two perforated cylinders. The insulator has a chamber in its interior diameter for the free evaporation of the liquid CO_2 and is provided with perforations for the exit of the escaping gas. It has a base 2½ inches in diameter, so that it may be placed solidly upon a table to withstand the hammer or mallet blows necessary for the compression of the snow.

DIRECTIONS FOR THE USE OF EQUIPMENT TYPE 2.

This equipment is especially designed to receive and collect the CO_2 snow crystals from the commercial cylinder. It has been found of great economy in offices and institutions where the CO_2 ice pencil is used frequently. One of the Chicago first aid stations employs the CO_2 crayon on an average of five or six cases every day, and since each crayon requires about four ounces of gas in its production, the contents of the small cylinder would be used up inside of a week, requiring frequent renewal, while the large cylinder with its capacity of about 80 CO_2 ice crayons will last for some time.

The complete equipment set up and connected is shown in Fig. 24. It consists of the crayon instrument type 2, a pair of floor stands for the support of the cylinder, and a special evaporating valve.

The cylinder shown is of the well-known commercial type, and is not furnished with the equipment but is supplied by any agent furnishing CO_2 gas to the Drug Stores and Soda Water Dispensaries in the particular territory. When ordering a cylinder with

twenty pounds of liquid CO_2 from the supply agent, it should be stated that the gas is to be used for medical purposes, which exempts it from the present war tax. The agent will then make a charge for the contents of the cylinder only, which charge averages $1.50 for twenty pounds. The cylinder itself is merely loaned, and remains the property of the gas manufacturer.

Fig. 91.—CO_2 ice crayon equipment—type 2

To make a CO_2 ice crayon proceed as follows:—

Place the cylinder in the floor stands with the valve at the lowest point. Attach the regulating valve to the cylinder valve nipple as explained under the heading "Special Supporting Valve Attached to Cylinder Valve." Next try the flow of gas through the regulating valve to become acquainted with its action. Be sure that the push button is properly entered in its place in the base of the instrument, and run up the instrument on the threaded end of the valve not less than half the length of the thread. Now open the regulating valve and adjust the flow of gas. If manipulated right, the instrument will fill with snow in less than one minute. When quite filled, the gas will have a tendency to blow back around the threads of the valve. Close the regulating valve and remove the instrument. When found upon examination that it contains sufficient snow, place it on a solid table, insert plunger and compress with the help of a mallet or hammer. A mallet is preferable, so as not to mar the end of the plunger. After compression, press upon the button in the instrument's base, and after loosening the pencil push it out upon the table with the help of a lead pencil or similar object. The pencil may be repointed after the point has melted away by contact, as will be obvious. It may also be shaped into a square form by placing it lengthwise upon a flat metallic surface. The square form will be found of advantage in the removal of birthmarks covering a large area, a section at a time.

Caution:—After the pencil has been made, be sure to close the cylinder valves tightly to avoid loss of gas.

GOODMANN CO. ICE CRAYON INSTRUMENT TYPE 3.

Painless local anesthesia confining insensibility to the area of operation is of such importance that many means to secure it have been devised.

The ethyl chloride method produces it by the rapid evaporation of the liquid sprayed upon the skin causing surface freezing by the removal of heat and consequent arrest of sensibility. However, the effect is of short duration, it does not sufficiently penetrate, and cannot be strictly localized. Moreover, it is usually co-associated with considerable pain during recovery, which is aggravated by the fact that a much larger area than needed for the operation has been affected.

The disadvantages of drugs such as cocaine and eucaine are too well known to require mention.

Fig. 35.—Local anaesthesia in a straight line

Freezing by means of Solidified Carbon Dioxide has every advantage of the best known agents without any of their disadvantages. Its method of application is shown in Fig. 66, and its superiority will be found in the following points:

It can be strictly localized.

It is rapid in action and produces superficial as well as deep anaesthesia at will.

It is practically painless during and after its application.

It exercises a decidedly friendly influence upon the tissues, and particularly in open wounds.

The anaesthesia effect is of sufficient length in duration to permit severe operation.

The cost of application is minimal, and it does not require registration.

It will be readily apparent that these advantages entitle this method to "first rank" in the field.

The procedure in using a CO_2 ice pencil is as follows:—

Place fitting *c* upon the valve nipple of the Carbonic Acid effect cylinder as shown in Fig. 27.

Remove plunger and place the instrument upon the smooth nipple of fitting *c* holding it with the left hand. Cap *b* closes the instrument during the collection of snow. If the cylinder valve has been tried previously, the operator will know how far to open it to obtain the proper flow of gas.

Fig. 26.—CO_2 ice crayon instrument, type 3

The CO_2 snow will collect rapidly within the instrument, and it will fill in about 30 seconds. When quite filled, the gas entering will have a tendency to push the instrument away from the valve nipple sometimes with a sputtering noise. This should not cause alarm, as there is no danger whatever in the manipulation.

The snow may now be compressed by means of plunger *a*.

Next select the proper applicator for the operation to be performed, remove cap *b* and insert applicator in its place.

Fig. 27.—Filling instrument with CO_2 snow

The diathesis knife *e* is designed to produce a straight line of insensibility previous to incision. Point *d* is equally suitable to produce the required effect for painless use of the larger sizes of hypodermic syringes. A few seconds application is usually sufficient.

METHOD OF TREATMENT SUGGESTED BY DR. BERNSTEIN

The proper technique in using the CO_2 ice crayon in the various conditions in which it is applicable is very simple and a little caution in the beginning to avoid giving too extreme or deep a freezing is all that is necessary to enable the operator to soon acquire skill in its entire usefulness.

The lesion to be treated should be first thoroughly cleansed in order to remove any sebaceous material, scales or crusts, which would interfere with the freezing process.

The lesion to be treated should be picked up and held firmly between the fingers as shown in Fig. 11, so that it is free from the

Fig. 38.—Crateriform Epithelioma. Previous to treatment with CO_2 ice.

surrounding tissues. Where this is not possible, it is advisable to protect the surrounding areas by chamois skin, cutting a small hole through the same just large enough to permit the lesion to be treated.

The crayon properly shaped is now ready to be applied to the area, but should first be wiped over with a piece of gauze to remove the fuzz or melting snow which has gathered about it. This having been done, immediate contact should be made to the part to be frozen, varying the application in both time and pressure depending upon the depth, the location, and the character of the lesion, the operator varying the pressure from light to medium to heavy.

In treating about mucous membranes or about the eye there should be protection with chamois skin, and absorbent cotton as well, if necessary, for in this way it will often be possible to prevent unnecessary pain and reaction. In treating lesions on the upper eyelid it is well to insert beneath it the ordinary wooden tongue depressor, which has first been thoroughly sterilized by boiling. This enables the operator to exert the necessary pressure upon the eyelid without fear of harming the eye itself. This is decidedly superior to inserting metal substances beneath the eyelid because of the rapidity with which they absorb the cold; wood in itself being a decidedly poor conductor. In working about the mouth care should as well be taken that none of the solidified mass is permitted to drop within.

Fig. 26.—Applying CO_2 ice pencil, protecting fingers with chamois skin or gloves

In treating large areas the solidified mass may be removed from its mold and handled with several layers of chamois skin about it. This should appeal as a more sensible way than having the operator wear thick, heavy, cumbersome gloves, which would interfere with his delicacy of touch in properly regulating the amount of pressure.

In treating the larger lesions which extend over considerable area the moulded coupon can be used lengthwise, always remembering that the solidified mass freezes well beyond the area treated, so that at no time should the freezing substance be allowed to overlap the area just beyond it.

THE AFTER TREATMENT OF FROZEN LESION

It is advisable to wait until the lesion treated has entirely thawed out before removing the chamois skin which has been placed over it to protect the surrounding skin because of the fact that the chamois may at times be frozen to the epidermis. This is frequently the rule when working about the mucous membranes where considerable moisture is present. It is also advisable to remove the chamois skin protector with great care when treating the lesions about the mucous membrane of the lips and the orbit because of the peculiar habit which the chamois skin has of often adhering closely to the mucous membrane surface.

Fig. 30.—Healing result one week after treatment

If there is decided pain after the treatment the free application of ice water compresses seems to have an ameliorating influence. This, however, is usually not necessary in the majority of the lesions treated, and should only be continued until the decided pain has ceased, because it will materially interfere with the formation of a dry, hard crust, which is of so much importance in the production of admirable end results.

Lesions which are of the non-infectious type should be kept as free from pus infection as is possible. Where there is unusually large bleb formation, which perhaps may become uncomfortable from its tension, it should be carefully and aseptically opened at its base, but should not be further interfered with, because Nature's covering can in no way be so admirably duplicated.

It is always of decided advantage to never interfere with the crusting or scabbing which takes place. If on the exposed surfaces of the body, and there is no secondary infection present, they are to be left severely alone until they drop off. If, however, on the covered portion of the body where the rubbing of the clothing would interfere, it is necessary to protect the same with the large size of the ordinary aerated vaccination shield, which permits free access of air, and which seems to be so necessary an adjunct for ideal healing. Absolutely no covering whatsoever should be placed over the lesions treated upon the exposed portions. Where, however, secondary infection has taken place, the scab or crust

Fig. 31.—Six weeks after treatment. Area smooth, white and scarless

may be removed and the lesion gently cleansed from time to time with boric acid solution. Frequently patients return with much alarm and concern because of the fact that they have accidentally removed the scab or crust. This need cause no unnecessary alarm because of the fact that another one will rapidly form. Occasionally lesions will shed their scabs only to form another one, and so continue until the entire area has healed over. Where there is free exudation going on, the patient should be instructed to merely wipe away the exuding serum or pus, always from below the lesion and never from its surface.

Complete Equipment Prices

Equipment type 1, consisting of instrument type 1, [illegible] and stand, Fig. 23 ..... $45.00

Equipment type 2, consisting of instrument type 2, special evaporating valve, [illegible] stands, Fig. 24.. 25.00

Equipment type 3, [illegible] type 3, Fig. 26, cylinder and stand, [illegible] 35.00

DISCONTINUED.

Detail Prices

Instrument type 1 in leather case, Fig. 15 ..... $25.00

Instrument type 2 in shipping case, Fig. 25 ..... 16.00

Instrument type 3 in leather case, Fig. 26 ..... 15.00

Office cylinder with liquid CO_2 ..... 15.00

Office cylinder [illegible] Fig. 22 ..... 6.00

Office cylinder stand [illegible] for table, Fig. 9 ..... 6.50

Commercial cylinder [illegible] Fig. 18 ..... 6.00

Special evaporating valve, Fig. [illegible] 5.00

Thermos Bottle, Fig. 7 ..... 3.00

"Solidified Carbon Dioxide" by Dr. Ralph [illegible] 1.00

"CO_2 Ice Therapy" by J. C. Goosmann ..... .50

Renewal [illegible] office cylinders 2.00

DISCONTINUED

Terms

All prices are cash with order. Special terms of payment can be arranged upon request. Shipments will be made by Express unless otherwise stipulated.

Guarantee

Every instrument is guaranteed to be without defect of workmanship and material and money will be refunded if it fails to produce a perfect CO_2 Ice Crayon.

DEFENDANT'S EXHIBIT T 549-550

The Rochester Herald, Sunday, March 9, 1924.

New Cooler Apparatus on Market

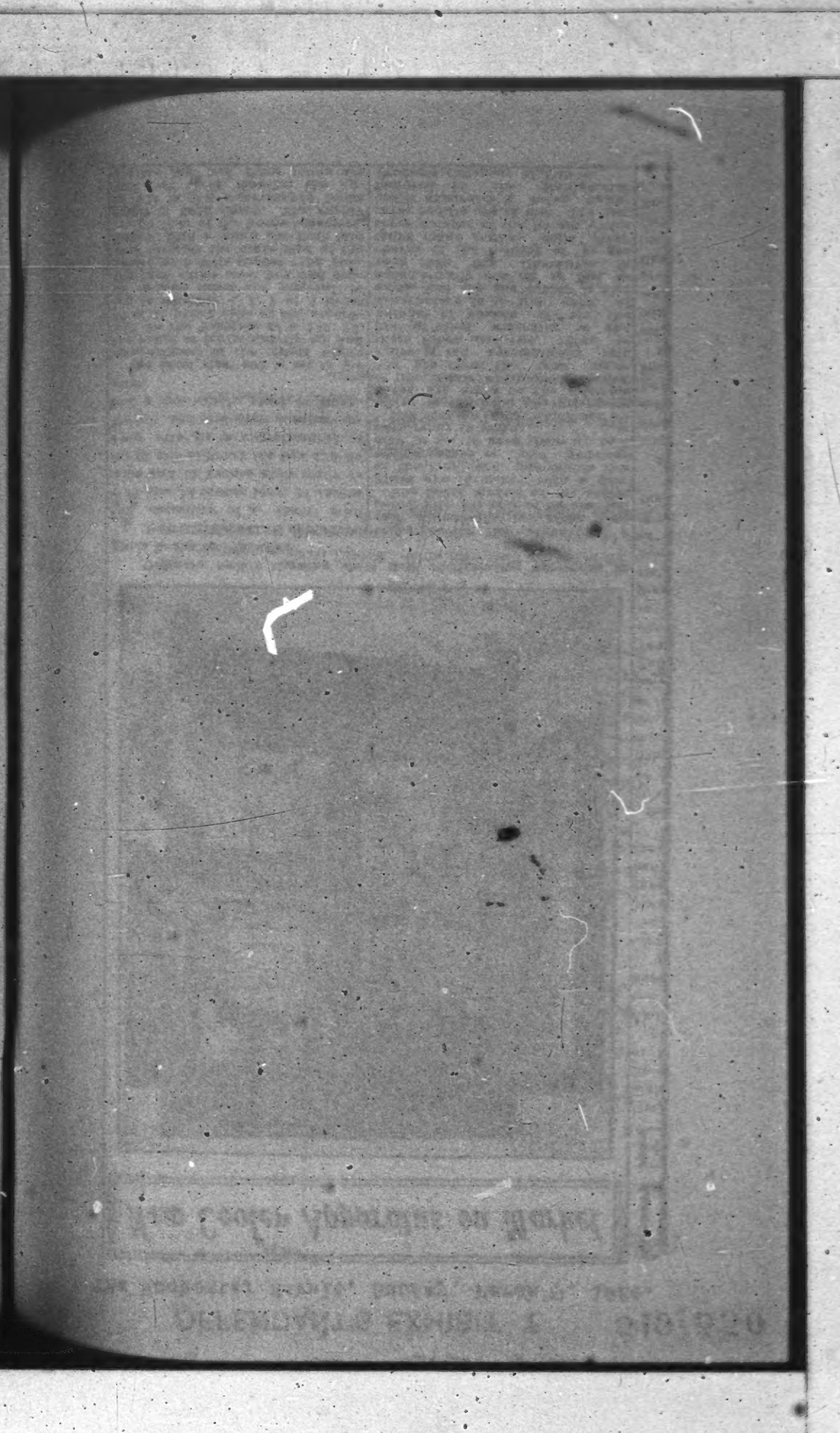
Ordinary bottles showing sheet steel refrigerating apparatus in place in the ice chamber.

A REFRIGERATING apparatus, consisting of a sheet steel box 14 inches long, 11 inches wide and 12 inches high, made to set in any ordinary ice box and do away with ice is manufactured in Detroit, and will have a salesroom and a gas supply plant in Rochester.

The sheet steel box is set in the compartment of the icebox where the cakes of ice ordinarily go, and will do the business of a 100, 75, 50 or 25 pound cake of ice, according to whether 4, 3, 2 or 1 pipes or vacuum tubes are inserted in the back of the steel box and connected by a little copper pipe, running through the drain pipe of the icebox, with a small gas tank laid on the floor of the house basement, cellar or back porch. The supply of gas is the cigar-shaped tanks will last three months, the operators say, and these tanks are recharged by the company at a cost absurdedly low when compared with the cost of natural ice.

The latest models of the cooler boxes are furnished with a door in the front end, into which ice cream or cold pudding may be set to keep them ice cold until ready to serve.

The vacuum tubes, which are inserted in the back of the cooler boxes, are made on the principle of the inside of thermos bottles. The gas from the tank below stairs is fed automatically into these tubes, one two, three or four of them, according to the number of pounds of ice the householder is in the habit of using, and the gas supply is also automatically cut off as fast as each tube thaws. Operatives in charge of the refilling of the gas tanks make regular calls every three months at the houses where these coolers are in use. The new cooler apparatus is being manufactured by the Refrigerator Products Company of Detroit.



purposes proposition success beyond question try raise sufficient money to incorporate any preliminary expense you may offer five for one as inducement party putting up this money will make fortune you may bring any one here to make inspection would like to have you come any event as I will wait here until apparatus completed.

Bright.

DEFENDANT'S EXHIBIT V

1923 Jul. 2 PM. 4 53.
UB590 9.

Detroit, Mich., 2, 4:38 P.

A. L. Miller, 594 Plymouth Ave., Rochester, N. Y.:

Tried get you last two nights will phone tonight.

Bright.

[fol. 552] IN UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

E. 3119

AMERICAN PATENTS DEVELOPMENT CORPORATION (Substituted for International Patents Holding Corporation) and Dry Ice Corporation, Plaintiffs,

against

CARBICE CORPORATION OF AMERICA, Defendant

Charles Neave, George C. Dean, and Clarence D. Kerr for the Plaintiff.

Darby & Darby, by Samuel E. Darby, Jr., for the Defendant.

OPINION—April 21, 1928

CAMPBELL, D. J.:

This is an action in equity in which plaintiff charges the defendant with the infringement of patent No. 1,595,426, issued to Thomas B. Slate, for refrigerating apparatus,

dated August 10, 1926, an earlier patent No. 1,511,306, issued to said Slate, for improvement in methods of and apparatus for refrigeration and preserving perishable products, dated October 14, 1924, having been withdrawn from suit on the opening of the trial.

Defendant offers the defenses of invalidity and non-infringement.

[fol. 553] Plaintiff bases this suit on claims 2, 3, 4, 6, 7, and 9 of patent No. 1,595,426, which read as follows:

"2. A heavily insulated package enclosing in close proximity to a parcel or mass of material not damaged by overfreezing during shipment, a quantity of frozen carbon dioxide insulated from but in freezing relation to said parcel or mass so that portions of the material are more directly and intensely refrigerated than other portions for the purpose and with the result of sufficiently refrigerating more remote portions, whereby on absorption of heat through said insulation, said carbon dioxide passes directly from the solid to the gaseous state; and said gas, as formed, escapes in freezing and insulating relation to said materials.

3. A transportation package consisting of a vented protective casing of insulating material enclosing a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product in freezing proximity to said carbon dioxide and the gas evaporated therefrom and arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

4. A protective casing of insulating material having therein a quantity of frozen carbon dioxide sufficient to afford refrigeration for the desired period and a quantity of freezable product separated from but in freezing prox-
[fol. 554] imity to said frozen carbon dioxide and insulated by the gas evaporated therefrom.

6. A transportation package consisting of a protective casing of insulating material having packed therein a quantity of frozen carbon dioxide in an insulating container and a quantity of freezable product in freezing proximity to said frozen carbon dioxide and the gas evaporated there-

from, arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products.

7. A transportation package consisting of a vented protective casing of insulating material having packed therein a quantity of freezable product in freezing proximity to a quantity of frozen carbon dioxide sufficient to afford the desired amount of refrigeration.

9. An insulated shipping case, similar parcels of perishable products packed solidly in said case, surrounding and supporting an insulated container of frozen carbon dioxide, having dimensions corresponding to and fitting among the said parcels."

To me this suit appears to be an attempt on the part of plaintiff to do by indirection what it could not do directly, viz., obtain a monopoly in the manufacture and sale of solid carbon dioxide as a refrigerant, which the patentee did not discover, nor has he a patent for it specifically.

[fol. 555] No process or method is claimed nor is one described in the patent in suit. What is enumerated in the claims in suit is a refrigerating apparatus, material to be refrigerated, and frozen carbon dioxide as a refrigerant.

Plaintiff does not make nor sell nor has it licensed any one to make the refrigerating apparatus claimed in the patent in suit.

All that plaintiff or defendant does is to manufacture and sell solid or frozen carbon dioxide, the chemical symbol of which is CO_2.

Plaintiff does not and cannot claim to be the discoverer of solid carbon dioxide.

Since 1845, solid carbon dioxide has been known to be one of if not the coldest elements ordinarily met with and having a temperature of 148°.

It was also known long before the earliest date with which we are here concerned that solid carbon dioxide could be pressed into solid blocks, that when exposed to the atmosphere it sublimed, that is, it went into a gaseous state without passing through the liquid state, very slowly, and that notwithstanding its extremely low temperature, its evaporation caused the formation of an insulating layer of gas around the solid, which permitted it to be touched without danger.

With this knowledge its use as a refrigerant was naturally and logically suggested.

This clearly appears from the prior art, British patents No. 13,684, of 1891, to Tichborne, Darley, Geoghegan and Purcell, for an improved process and apparatus for the manufacture of solid carbonic acid, and 7,436, of 1895, to [fol. 556] Elworthy and Henderson, for improvements in methods of solidifying carbon dioxide, United States patent No. 579,866, to Elworthy, for apparatus for solidifying carbon dioxide, issued in 1897, French patent No. 333,181, to Grepin, for device for preserving food stuffs and the like by means of cold produced by carbonic acid, issued in 1903, and 344,957, to Heyl & Co., for method of storing and shipping carbonic acid in solid state, issued in 1904, British patent No. 2,450 of 1906, to Elworthy, for improvement in processes for solidifying carbonic acid and apparatus therefor, and from the following publications offered in evidence:

Liquid Air, Sloane, 1900; Dictionary of Applied Chemistry, Sir Edward Thorpe, 1921; Laboratory Text Book of General Chemistry, Pellew, 1901; The Journal of the Society of Chemical Industry, 1892 and 1904; Treatise on Chemistry, Roscoe & Schorlemmer, 1896 and 1920; Spons' Encyclopaedia of the Industrial Arts, manufactures and Commercial Products, 1879; Outlines of Chemistry, William Odling, 1870; Chemical Lecture Experiments, Newth, 1892; Elements of Chemistry, Graham, 1850; Dictionary of Chemistry, New Edition, Thomson, 1845-1850; Dictionnaire de Chimie, Wurtz, 1876; Herichte, 1884, Artificial Refrigeration, 1891.

There are certain inherent characteristic and physical properties of solid carbon dioxide, among which are the evaporation or changing of its state from the solid form to the gaseous state when exposed to the atmosphere, which change inevitably creates a surface layer of gas around the solid block of gaseous carbon dioxide; that carbon dioxide [fol. 557] will permeate through any space or material with which it comes in contact unless the material be air-tight and impervious to air or other gas, and that carbon dioxide in a gaseous state acts to some extent as a preservative.

United States patent No. 256,299, to Dickerson, for process of refrigerating and preserving meat and other articles, issued in 1882.

In fact all that we know today about solid carbon dioxide pertinent to this suit, except perhaps its higher ratio of refrigeration as compared to water ice, was known many years prior to any date with which we are here concerned; and even if it has been found that such ratio is higher than 2 to 1, it is because of the inherent properties of the solid carbon dioxide, and not something which results from any improvement in manufacture by the plaintiff, or the teachings of the patent in suit.

What is the patent for?

It is not for a method or process.

Plaintiff contends that the thing claimed is a package, goods baled, boxed, or otherwise enclosed for transportation, and that the manufacture of this package is packing the ice cream and the frozen carbon dioxide in the novel relation specified in the patent, and that such a package is an article of manufacture, within the meaning of the patent statute.

Defendant contends that the patent is for a container.

In my opinion the defendant is correct and no infringement was shown, because at most defendant could only be a contributory infringer, and to sustain such a charge it [fol. 558] would have been necessary to show that defendant contributed materials going into the construction of the container, and such charge would not be sustained by showing that commodities were used in the container.

Assuming, but not finding, that the patent in suit was for a combination comprising the refrigerating apparatus, materials to be refrigerated, and frozen carbon dioxide as a refrigerant, there was no infringement shown.

The use of solid carbon dioxide as the refrigerant, restricted the materials to be refrigerated to materials that would not be injured by freezing, such as ice cream, and if plaintiff is correct in its contention that the furnishing of the refrigerant by the defendant to Marchiony constituted infringement, then it could as well claim that the furnishing of the materials to be refrigerated was an infringement.

Neither of these contentions can be sustained because both the refrigerant and the materials to be refrigerated are perishable, and in each operation the refrigerant is consumed.

Even if it be held that the patent in suit is for a combination, one element of which is solid carbon dioxide, the defendant did not infringe the patent in suit by furnishing the solid carbon dioxide, as that was a perishable product, consumed in the operation, and the patentee has not patented and could not patent solid carbon dioxide. Morgan Envelope Co. v. Albany Paper Co., 152 U. S. 425, 38 L. Ed. 500.

The case at bar is clearly distinguishable from Leeds & Catlin Co. v. Victor Talking Machine Co., 213 U. S. 325, [fol. 559] 330, 333, 335, in which case the phonographic disc record was not consumed in the operation, and in that sense was not perishable.

It is no answer for the plaintiff to contend that the protective casing of the package may not be of a character which would make it worth retaining, because the patent would read on one which would, and the shipping cases clearly are made in a substantial manner, with the intention of retaining them.

In any event, defendant did not supply protective casings or shipping cases, nor did it direct the purchase of its product where to purchase the same, but the containers used by Marchiony, in the first instance, were purchased where plaintiff told him, and thereafter in connection with the solid carbon dioxide furnished by plaintiff and defendant were purchased where and from whom he found it most advantageous, changing the source of his supply at will, without ever obtaining the consent of the plaintiff, and that such consent was not necessary.

The containers thus purchased by Marchiony were for a short period of time used in connection with the solid carbon dioxide of the plaintiff and defendant, he dividing his business between them, and therefore by the purchase of the containers under such conditions, Marchiony had a license from plaintiff to use them.

No consideration of the validity of the patent is required as I am convinced that even if the patent be valid, infringement has not been shown.

A decree may be entered dismissing the complaint with costs.

[fol. 560] In United States District Court, Eastern District of New York

In Equity. No. 3119

American Patents Development Corporation (Substituted for International Patents Holding Corporation and Dry Ice Corporation), Plaintiff,

vs.

Carbice Corporation of America, Defendant

Final Decree—Filed May 3, 1928

This cause having come on for trial and final hearing, and having been argued by counsel for the respective parties, and thereupon, upon consideration thereof, it is,

Ordered, adjudged, and decreed that the complaint herein be and it is hereby dismissed with costs to the defendant taxed at $101.85, and that judgment may be entered for such amount in favor of defendant.

Dated May 3, 1928.

Marcus B. Campbell, U. S. D. J.

New York, New York, May 1, 1928.

Approved as to form.

Clarence D. Kerr, Counsel for Plaintiff.

[fol. 561] In United States District Court

[Title omitted]

Petition for Appeal

The plaintiffs herein, American Patents Development Corporation and Dry Ice Corporation of America, conceiving themselves aggrieved by the final decree entered herein on May 3, 1928, hereby appeal from said decree to the United States Circuit Court of Appeals for the Second Circuit for the reasons set forth in the assignments of error filed herewith, and pray that citation be issued as provided

by law to the above named defendant, commanding it to appear before said Circuit Court of Appeals to do and receive what may appertain to justice to be done in the premises; that a transcript of the pleadings, proceedings, testimony, exhibits and orders, together with a copy of the opinion of [fol. 562] this court filed in this case upon which said decree was entered, duly authenticated by the Clerk of the Court, be transmitted to the United States Circuit Court of Appeals for the Second Circuit under the rules in such cases made and provided.

American Patents Development Corporation and Dry Ice Corporation of America, by Charles Neave, Clarence D. Kerr, Counsel for Plaintiffs.

ALLOWANCE OF APPEAL

It is ordered, this 27th day of July, 1928, that the foregoing appeal be allowed.

R. A. Inch, United States District Judge.

[fol. 563] IN UNITED STATES DISTRICT COURT

[Title omitted]

ASSIGNMENTS OF ERROR

The plaintiffs above named, conceiving themselves to be aggrieved by the final decree filed herein on May 3, 1928, now appear by their solicitors and file, with the accompanying petition for appeal, the following assignments of error:

1. The Court erred in dismissing the bill of complaint.

2. The Court erred in not entering a decree in accordance with the prayer of the original bill of complaint as modified by the prayer of the supplemental bill of complaint.

3. The Court erred in not decreeing the Slate patent in suit, 1,595,426, particularly as to claims 2, 3, 4, 6 and 7

thereof, to be good and valid in law and infringed by the defendant.

[fol. 564] 4. The Court erred in holding claim 2 of Slate patent 1,595,426 not infringed by defendant.

5. The Court erred in that it did not decree that claim 2 of the Slate patent 1,595,426 has been infringed by defendant.

6. The Court erred in holding claim 3 of Slate patent 1,595,426 not infringed by defendant.

7. The Court erred in that it did not decree that claim 3 of the Slate patent 1,595,426 has been infringed by defendant.

8. The Court erred in holding claim 4 of Slate patent 1,595,426 not infringed by defendant.

9. The Court erred in that it did not decree that claim 4 of the Slate patent 1,595,426 has been infringed by defendant.

10. The Court erred in holding claim 6 of Slate patent 1,595,426 not infringed by defendant.

11. The Court erred in that it did not decree that claim 6 of the Slate patent 1,595,426 has been infringed by defendant.

12. The Court erred in holding claim 7 of Slate patent 1,595,426 not infringed by defendant.

13. The Court erred in that it did not decree that claim 7 of the Slate patent 1,595,426 has been infringed by defendant.

[fol. 565] 14. The Court erred in that it held that Marchiony had a license under the patent in suit to purchase solid carbon dioxide from defendant, whereas it should have held that defendant's sale of solid carbon dioxide to Marchiony, with the intent that it be used by Marchiony in the combination of Slate patent 1,595,426, constituted an infringement of the said patent.

15. The Court erred in not holding that the defendant had sold solid carbon dioxide with the intent that it be used in the combination of the patent in suit, and that defend-

ant thereby contributed to the infringement of claims 2, 3, 4, 6, 7 of Slate patent 1,595,426.

16. The Court erred in that it held that, as the solid carbon dioxide furnished by defendant was a perishable product, furnishing such product did not constitute an infringement of the Slate patent 1,595,426, whereas it should have held that supplying such product with the knowledge and intent that such product be used in the combination of Slate patent 1,595,426 constituted an infringement of the said patent.

17. The Court erred in that it held that the Slate patent in suit, No. 1,595,426, is for a container.

18. The Court erred in that it did not find that the patent in suit is for a refrigerating apparatus in the form of a package, comprising in combination the container or casing of insulating material, and its contents packed therein, [fol. 566] namely, material to be refrigerated and frozen carbon dioxide as a refrigerant.

19. The Court erred in holding that to sustain the charge that the defendant is a contributory infringer, it was necessary to show that defendant contributed materials going into the construction of the container.

20. The Court erred in that it held Marchiony had a license under the patent in suit which permitted him to purchase containers for making up the patented apparatus, from container makers not approved by the plaintiff.

21. The Court erred in that it held Marchiony had a license under the patent in suit which permitted him to purchase from the defendant solid carbon dioxide for making up the patented apparatus.

22. The Court erred in that it held that Marchiony had a free license under the patent in suit, which permitted him to make up the patented apparatus without payment of royalty, using containers not purchased from makers approved by plaintiff, and solid carbon dioxide not purchased from plaintiff.

23. The Court erred in that it did not decree that issuance of an injunction restraining the defendant from fur-

ther infringement of claims 2, 3, 4, 6 and 7 of Slate patent 1,595,426, and each of them.

[fol. 567] 24. The Court erred in that it did not direct an accounting by defendant to ascertain the damages and profits resulting from the infringement by defendant of claims 2, 3, 4, 6 and 7 of Slate patent 1,595,426.

25. The Court erred in awarding costs to defendant, whereas it should have awarded costs to plaintiffs.

Charles Neave, Clarence D. Kerr, Solicitors for Plaintiffs.

[fol. 568] In United States District Court

[Title omitted]

Notice of Lodgment of Narrative Statement of Evidence

To Messrs. Darby & Darby, 220 Broadway, New York, N. Y.

Sirs: Please take notice that I am this day lodging in the office of the Clerk of this Court at the Post Office Building, Borough of Manhattan, City of New York, the condensed statement of the proceedings, evidence and exhibits at the trial of this case, which has heretofore been submitted to and approved by you and that on February 28, 1929, at 10:30 A. M., or as soon thereafter as counsel can [fol. 569] be heard, I will move that the Court enter an order approving the same as true, complete and properly prepared.

February 18, 1929.

Clarence D. Kerr, Counsel for Plaintiffs-Appellants.

Service of copies of the above notice and attached proposed order and copy of testimony as restated by plaintiffs-appellants acknowledged this 18th day of February, 1929.

Darby & Darby, Counsel for Defendant-Appellee.

[fol. 570] IN UNITED STATES DISTRICT COURT

[Title omitted]

STIPULATION AS TO CONTENTS OF RECORD

It is hereby stipulated by and between the parties herein, through their respective counsel, that the printed record on appeal to the United States Circuit Court of Appeals in the above entitled cause shall consist of the following papers and documents:

1. Bill of Complaint filed May 10, 1927.
2. Answer thereto filed June, 1927.
3. Amended Answer filed November 15, 1927.
4. Petition and Order for leave to file a Supplemental Bill, filed January 19, 1928.
5. Supplemental Bill of Complaint, filed January 19, 1928.

[fol. 571] 6. Testimony in Narrative Form as agreed on.

7. Plaintiff's Exhibits 1, (2, 3, 4, 5, 6 condensed), 7, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22.

8. Defendant's Exhibits (A, B condensed), C (10 excerpts), D-1 to D-6 inclusive, E-1 to E-16 inclusive, F, G, H-1 to H-14 inclusive I, K, L, M, N, O, P, R, S, T, U, V.

9. Opinion of the Honorable Marcus B. Campbell, United States District Judge.

10. Decree.

11. Plaintiffs' Assignments of Error.

12. Petition for and Order Allowing Appeal.

13. Notice of Lodgment of Condensed Statement of Evidence, with Proof of Service.

14. This stipulation as to Contents of Record and Order thereon.

15. Clerk's Certificate.

It is further stipulated and agreed that all exhibits not here stipulated to be included in the printed record shall be produced in the Court of Appeals as physical exhibits.

February 18, 1929.

Clarence D. Kerr, Counsel for Plaintiffs-Appellants.
Darby & Darby, Counsel for Defendant-Appellee.

The statement of the evidence and the exhibits referred [fol. 572] to under the foregoing stipulation is hereby ap-

proved as true, complete and properly prepared, and the Clerk of the Court is directed, in certifying the Record, to include the said statement of the evidence and exhibits in accordance therewith without requiring any further approval of the evidence and exhibits by the Court.

Marcus B. Campbell, United States District Judge.

February 28, 1929.

[fol. 573] In United States District Court

[Title omitted]

Stipulation re Record

It is hereby stipulated and agreed, that the foregoing is a true copy of the transcript of the record of the said District Court in the above entitled matter as agreed on by the parties.

Dated March —, 1929.

Clarence D. Kerr, Attorney for Appellants. Darby & Darby, Attorneys for Appellee.

[fol. 574] Clerk's certificate to foregoing transcript omitted in printing.

[fol. 575] In United States Circuit Court of Appeals for the Second Circuit

American Patents Development Corporation (Substituted for International Patents Holding Corporation) and Dry Ice Corporation of America, Appellants,

vs.

Carbice Corporation of America, Appellee

Before L. Hand, Swan, and Augustus N. Hand, Circuit Judges

Appeal from the District Court of the United States for the Eastern District of New York

OPINION

Upon the trial of the plaintiffs' suit for patent infringement the defenses were invalidity and non-infringement. From a decree finding no infringement and dismissing the bill of complaint, the plaintiffs have appealed. Reversed.

American Patents Development Corporation is the owner by assignment of United States Patent No. 1,595,426 to Thomas B. Slate for a "refrigerating apparatus", or, as it is described in several of the claims, a "transportation package", consisting of a combination of three elements, namely, an outside container or shipping case, solid carbon dioxide, which is the refrigerant, and the food stuffs to be [fol. 576] refrigerated. The other plaintiff, Dry Ice Corporation, has been granted an exclusive license under said patent. It manufactures and sells solid carbon dioxide, which it calls "dry ice", and purchasers from it are authorized to use, and do use, the substance so purchased to make the transportation packages described in the patent in suit. The defendant Carbice Corporation of America is likewise a manufacturer and seller of solid carbon dioxide, which it markets under the trade name of "carbice". It is charged with contributory infringement in that it persuaded a former customer of the Dry Ice Corporation to purchase defendant's carbice, with the intent that such customer should use it to make the patented package, which he did. The opinion below is reported in 25 F. (2d) 730.

Charles Neave for appellants; George C. Dean and Clarence D. Kerr, of counsel.

Darby & Darby, for appellee; Samuel E. Darby, Jr., of Counsel.

SWAN, Circuit Judge:

The patent in suit relates to the refrigeration of perishable products of a sort not to be damaged by excessive freezing, such, for instance, as ice-cream, by packing them around a block of solidified carbon dioxide, and enclosing the whole mass in a box or shipping case. Carbon dioxide (CO_2) may exist as a gas, a liquid, or a solid, depending upon the conditions of temperature and pressure to which

[fol. 577] it is subjected. As a solid it has an excessively low temperature—approximately minus 140 degrees Fahrenheit. When solid carbon dioxide absorbs heat it sublimes, that is, it evaporates as a gas without passing through the liquid state. This gas is itself very cold, having a temperature of minus 110 degrees. The rate of evaporation is slow, and one volume of the commercial solid carbon dioxide will evolve approximately 500 volumes of gas. These facts were known long before the patentee Slate entered the field. Prior patents show machines and processes for producing solid carbon dioxide and molding it into bricks or blocks. They suggest its use as a refrigerant and as a substitute for water ice, but none of them suggests the arrangement of refrigerant and things to be refrigerated which the patentee insists upon.

The prior art had taught that a refrigerant should be so placed as to be more accessible to heat than the products to be refrigerated. In the ordinary ice box, the water ice is placed in a compartment at the top and the interior of the box is cooled by the circulation of convection currents of air. The accepted practice in shipping ice-cream was to pack ice and salt in a container with the can of ice-cream in the center, cooling being effected by conduction. Slate reversed this process. He put the refrigerant in the center of the package, surrounding it with the ice-cream or other substance to be refrigerated, and enclosing all in a packing box or insulating wrapping. Thus the food stuff itself is made to help to insulate the solid carbon dioxide against outside heat. Further insulation is supplied by the constantly evolving gas which is a poor conductor of heat. The [fol. 578] gas being heavier than air, displaces the air until all the interstices within the packing box are permeated by the cold gas, which acts also as a refrigerant of those portions of the goodstuff remote from the solid carbon dioxide. The outside container or shipping case may be of any insulating material; in practice a box of wood, or of cardboard or corrugated paper, which may be thrown away, is used. The cake of solid carbon dioxide placed in the center of the package may also be enclosed in a box or, as appears to be the practice, it may merely be wrapper in paper.

The refrigerant value of solid carbon dioxide is about

twice that of water ice, that is, one pound of the former will absorb during evaporation twice as many heat units as will one pound of the latter while melting. But by itilizing the peculiar and well-known properties of solid carbon dioxide by means of the aboye described arrangement of the package, the patentee has made its refrigerating efficiency approximately fifteen to twenty times that of a like weight of water-ice. The cost of "dry ice" is about ten times that of water ice; but its high refrigerating efficiency, its capacity to "melt" without becoming a liquid, and the saving in weight and hence in freight, give transportation packages made up with dry ice advantages which more than offset its greater cost. Packages made up in accordance with the teaching of the patent have been used to an impressive extent. The Dry Ice Corporation began selling solid carbon dioxide commercially in March 1925. In that year it sold 366,000 pounds. Up to the end of 1927 it had sold nearly [fol. 579] five million pounds, of which approximately ninety percent. has been used in transportation packages by the ice-cream trade. Prior to the time when plaintiffs began to market solid carbon dioxide, this substance was not manufactured in quantities of any commercial importance. Counsel assert, and we think justly, that plaintiffs have created a new industry.

Slate's original application was filed January 10, 1924. A divisional application, covering one of the specific applications of the invention claimed in the parent application was filed September 27, 1924. This resulted in the issuance of the patent in suit on August 10, 1926. It is not a patent for a process. Process claims, originally included in the divisional application, were rejected and the rejection was acquiesced in. As issued, the patent is only for a "refrigerating apparatus" consisting of a combination of elements, all old, but combined, it is urged, in a novel arrangement to produce new and useful results in the art of refrigeration. Claims 2, 3, 4 and 6 are relied upon on this appeal. It will suffice to recite claim 3 as illustrative:

"A transportation package consisting of a vented protective casing of insulating material enclosing a quantity of frozen carbon dioxide sufficient to afford refrigeration

for the desired period and a quantity of freezable product in freezing proximity to said carbon dioxide and the gas evaporated therefrom and arranged so that said frozen carbon dioxide is less accessible for exterior heat than said freezable products."

We are satisfied that Slate discovered how to make up a package consisting of freezable food stuffs, solid carbon dioxide and their enveloping container, in an arrangement not previously known and producing the new and useful [fol. 580] result of making practicable the shipment of such foodstuffs to greater distances than was previously possible. That this discovery would be patentable as a process we cannot seriously doubt. See Yablick v. Protecto Safety Appliance Co., 21 F. (2d) 885, 886 (C. C. A. 3):

"The patentees translated a more or less isolated and hitherto comparatively unimportant fact of chemistry into a useful industry."

It is argued that the process is merely the operation of the peculiar properties of solid carbon dioxide, and that laws of nature may not be patented. Morton v. Infirmary, 5 Blatch. 116 (C. C. S. D. N. Y.); O'Reilly v. Morse, 15 How. (U. S.) 61, 115. Nevertheless, a method of utilizing by specified physical means the operations of a law of nature is patentable, and this is what Slate taught. He did not, however, claim it as a process; he claimed only the "package", product of his process. So the patent, if sustainable, must fall within the statutory phrase "machine, manufacture or composition of matter". Rev. Stat. sec. 4886. The defendant denies that it is either.

"Manufacture" seems the most apposite. The courts have given it a comprehensive definition. In Johnson v. Johnston, 60 F. 618, 620 (C. C. W. D. Pa.), Acheson, J., said:

"The term 'manufacture', as used in the patent law, has a very comprehensive sense, embracing whatever is made by the art or industry of man, not being a machine, a composition of matter, or a design."

This has frequently been cited with approval, and many courts have sustained patents for constructions which are

not ordinarily thought of as a "manufacture". See Riter-[fol. 581] Conley Mfg. Co. v. Aiken, 203 F. 699, 703 (C. C. A. 3); Cincinnati Traction Co. v. Pope, 210 F. 443, 446 (C. C. A. 6); International Mausoleum Co. v. Sievert, 213 F. 225, 228 (C. C. A. 6); In re Hadden, 20 F. (2d) 275 (App. D. C.); American Fruit Growers v. Brogdex Co., 35 F. (2d) 106 (C. C. A. 3). In the case last cited the court sustained a product claim consisting of a combination of fresh citrus fruit and a small quantity of borax carried by the rind in an amount sufficient to render the fruit resistant to blue mold decay. Of this the court said (page 108):

"The complete article is not found in nature and is thus an article of manufacture."

In thinking of an article of manufacture one naturally thinks of a permanent contrivance, which does not operate upon a subject that is part of itself. The mind unconsciously resists the incorporation of that subject into the "manufacture" itself. Here we have something, the food stuffs, which it is the object of the package to refrigerate and deliver; and which at the same time is one of the elements making up the package, the article of manufacture. But we see no reason why a substance may not play this dual role without invalidating the patented combination. Paraphrasing the language of Mr. Justice McKenna in Leeds & Catlin Co. v. Victor Talking Machine Co., 213 U. S. 325, 335, we may say that if the operative relation of the food stuffs to the package were merely that of the log to the saw in the mill, wheat to the rollers which grind it, or pins to the machine which produces them; in other words, in no more operative relation than a machine and its product, [fol. 582] are, the invalidity of the combination would be scarcely questionable. But here the food stuffs are really a constituent element of the combination package; their arrangement causes them to help insulate the refrigerant from outside heat, thereby retarding its evaporation. They themselves operate upon another element of the combination and are not merely a subject operated upon by the article of manufacture. Nor do we see any reason for refusing to say that the package is a "manufacture" because it is intended to have only a temporary life. While it lasts,

surely it is a combination of physical elements never put together before, and exceedingly useful. True, it perishes in use; when the solid carbon dioxide has evaporated, the combination no longer exists. But it is not fatal to a patent that the patented device is to be destroyed by its use. Instance the case of a patented torpedo, referred to by way of illustration by Mr. Justice Brown in Morgan Envelope Co. v. Albany Co., 152 U. S. 425, 434. We think that the "transportation package" may be the subject of a valid patent.

Validity is also attacked upon the ground that the disclosure is insufficient in that it does not proportion the quantity of solid carbon dioxide to the quantity of product to be refrigerated or specify detailed rules for making up the package by one attempting to practice the patent. It is true that the size of the package, the duration of the intended transportation, the temperature of the outside air and of the product to be refrigerated, the character of insulation supplied by the container, as well as other factors, no doubt have to be considered to make up the package in [fol. 583] the most efficient and economical manner possible. Nevertheless, shippers are evidently able to make up packages sufficiently efficient for practical purposes by utilizing what the patent discloses. Defendant's expert Churchill testified that he shipped to his niece in Oregon a 60 pound package containing three quarts of ice-cream and that "the ice-cream arrived like a block of cement" and only 22 pounds of the solid carbon dioxide had sublimed in the transit. Apparently he used an unnecessarily large quantity of the carbon dioxide, but because the patent cannot be used in the most efficient manner possible without experience does not prove that the disclosure is insufficient. See Franc-Strohmenger & Cowan v. Arthur Siegman, 27 F. (2d) 785 (C. C. A. 2). It disclosed enough to enable Dr. Churchill to make up a "transportation package" of the character described in the patent and sufficiently efficient to deliver the ice-cream in properly refrigerated condition. The patent states the physical arrangement of the elements which make up the claimed combination. While the relative quantities of food stuffs and dry ice will vary with the size of the package, length of journey, etc., the claimed arrangement of elements remains constant. It is the arrangement which is vital.

As to the attack upon validity founded upon the assertion of prior knowledge and use, it seems sufficient to say that while the evidence discloses knowledge of the general properties of solid carbon dioxide, it shows clearly that no one before the patentee had thought of using the food stuffs as insulation for the carbon dioxide nor of utilizing the gas generated upon sublimation as additional insulation [fol. 584] and also as a refrigerant of the remote portions of the food stuffs; that is to say, no one had made up a package with the solid carbon dioxide in the center—no one had utilized the known properties of the refrigerant by the specific arrangement discovered by the patentee.

There can be no reasonable doubt about the defendant's complicity in Marchiony's infringement of the patent, which is all one means by contributory infringement. See Individual Drinking Cup Co. v. Errett, 297 F. 733 (C. C. A. 2). Marchiony was a manufacturer of ice-cream. He became a purchaser of plaintiff's dry ice and thereby obtained a license to use it in making up transportation packages under the patent in suit; but his license did not authorize the combining into the patented arrangement of dry ice purchased from others than plaintiffs. In March, 1927, defendant sold solid carbon dioxide to Marchiony who used it in the same way as he had used that purchased from the Dry Ice Corporation. In view of defendant's advertisements, and its guarantee to Marchiony that its product would be as satisfactory as plaintiffs', there can be no doubt of defendant's intent to have Marchiony use its product to infringe the patent.

But it is urged, in reliance upon Motion Picture Co. v. Universal Film Co., 243 U. S. 502, that Marchiony did not infringe; that plaintiffs' attempt to restrict Marchiony in the use of solid carbon dioxide purchased from defendant is an attempt by indirection to extend their patent monopoly to cover an unpatented substance. There is, however, a [fol. 585] plain distinction between that case and this. It is brought out in the opinion of Mr. Justice Clarke in the Motion Picture case itself, at page 514, where he is considering the Button Fastener case which, he says, originated "the construction of the patent law which justifies as valid the restriction of patented machines, by notice, to use with

unpatented supplies necessary in the operation of them, but which form no part of them"; and again at page 518, where he declared the restriction invalid "because such a film is obviously not any part of the patent in suit." It is only unpatented materials which form no part of the patented machine which the Supreme Court held the purchaser of the machine may use at will. The solid carbon dioxide forms the most vital part of plaintiffs' patented package. Marchiony might legally use defendant's carbice in any way not covered by the patent in suit, but he could not manufacture the patented package without the plaintiffs' consent, a consent which they withheld unless the vital ingredient of its manufacture was purchased from them. To extend the doctrine of the Motion Picture as defendant contends, would completely destroy the monopoly of plaintiffs' patent. See George Close Co. v. Ideal Wrapping Machine Co., 29 F. (2d) 533, 535 (C. C. A. 1):

"What was 'to make' within the meaning of the patent law before the Motion Picture decision, is 'to make' within the law since that decision."

It is further urged that one who furnishes a perishable product which is not itself patented cannot as a matter of law infringe a patent for a device which utilizes the perishable product. Morgan Envelope Co. v. Albany Paper Co., 152 U. S. 425. The patent there involved called for a com- [fol. 586] bination of a roll of paper and a fixture for delivering the paper in sheets of convenient size. The plaintiff sold its fixtures with the understanding that purchasers should use therewith only paper purchased from the plaintiff. The defendant sold rolls of paper of its manufacture to persons who had previously purchased fixtures and paper from the plaintiff, with the knowledge and intent that the paper sold by defendant should be used with such fixtures. The court held that there was no infringement by defendant. At page 432, Mr. Justice Brown said:

"The real question in this case is, whether, conceding the combination of the oval roll with the fixture to be a valid combination, the sale of one element of such combination,

with the intent that it shall be used with the other element, is an infringement. We are of opinion that it is not. There are doubtless many cases to the effect that the manufacture and sale of a single element of a combination, with intent that it shall be united to the other elements, and so complete the combination, is an infringement. Saxe v. Hammond, Holmes, 456; Wallace v. Holmes, 9 Blatchford, 65; Barnes v. Straus, 9 Blatchford, 553; Schneider v. Pountney, 21 Fed. Rep. 399. But we think these cases have no application to one where the element made by the alleged infringer is an article of manufacture perishable in its nature, which it is the object of the mechanism to deliver, and which must be renewed periodically, whenever the device is put to use. Of course, if the product itself is the subject of a valid patent, it would be an infringement of that patent to purchase such product of another than the patentee; but if the product be unpatentable, it is giving to the patentee of the machine the benefit of a patent upon the product, by requiring such product to be bought of him. To repeat an illustration already put: If a log were an element of a patentable mechanism for sawing such log, it would, upon the construction claimed by the plaintiff, require the purchaser of the sawing device to buy his logs of the patentee of the mechanism, or subject himself to a charge of infringement. This exhibits not only the impossibility of this construction of the patent, but the difficulty of treating the paper as an element of the combination at all. In this view the distinction between repair and reconstruction becomes of no value, since the renewal of the paper is in a proper sense neither the one nor the other."

[fol. 587] This case has been much cited and there has arisen considerable doubt as to its precise meaning. Judge Lurton, afterwards elevated to the Supreme Court, discussed it at length in the Button Fastener case, 77 F. 288, 298 (C. C. A. 6). He says that Mr. Justice Brown's assumption that a combination of the machine for delivering the paper with the paper to be delivered was valid, was by his own argument shown to be unfounded in reason; and that what the court decided was that the sale of the paper fixture with the paper in it contained the implication of a right to renew when the paper was exhausted. This Judge

Lurton says is made clear by Mr. Justice Brown's citation of Wilson v. Simpson, 9 How. 108, in support of the decision. A somewhat similar view is expressed by Mr. Justice McKenna in Leeds & Catlin Co. vs. Victor Talking Machine Co., 213 U. S. 325, 335, where he says that if the operative relation of the paper roll to the mechanism was like that of the log to the saw in the mill (the illustration used by Mr. Justice Brown) then "the invalidity of the combination was hardly questionable." And he added that, besides, it was made a determinating circumstance that the paper perished by its use, and was to be periodically renewed "whenever the device was put to use". The "active cooperation of the disc to product the patented combination in the Victor case was contrasted with "the mere passivity of the paper" in the Morgan Envelope case, and this distinction was made the chief ground of differentiation. In Williams v. Barnes, 234 F. 339, 340 (C. C. A. 7), Judge Mack considered the principles for which the Morgan En- [fol. 588] velope case and the Victor case respectively stand, and said:

"The test is whether the element, as part of the patent combination, is perishable in its nature, consumed in the use, and necessarily to be replaced in each successive use of the combination. If it is, then, at any rate in the absence of some restriction, the purchaser of the device in which the combination is to be effected for practical use is impliedly licensed to replace the consumable element."

See also Judge Denison's comment in Lyman Mfg. Co. v. Bassick Mfg. Co., 18 F. (2d) 29, 37 (C. C. A. 6),

Whether the Morgan Envelope opinion be interpreted as a holding that the combination of fixture and paper roll was not a patentable combination, despite its some what perfunctorily asserted assumption to the contrary, or whether it be interpreted as an exception to the rule of contributory infringement, based upon implied license to renew ephemeral and subordinate parts of a patent combination, we do not think it can control the case at bar. The doctrine of implied license to renew perishable and subordinate parts is based upon the purchase from the patentee of enduring and important parts of the patented combination.

Heyer v. Duplicator Co., 263 U. S. 100; Wilson v. Simpson, 9 How. 109; Williams v. Barnes, 234 F. 339 (C. C. A. 7); Heyer Duplicator Co. v. Ditto, 6 F. (2d) 578 (C. C. A. 7); Lyman Mfg. Co. v. Bassick Mfg. Co., 18 F. (2d) 29; Bassick Mfg. Co. v. Ready Acto Supply Co., 22 F. (2d) 331, 340 (D. C. E. D. N. Y.). In the Morgan Envelope case the implication arose from the purchase of a dispensing machine intended to deliver a subordinate element "which must be renewed periodically whenever the device is put to use." Marchiony purchased nothing from the patentee ex- [fols. 589 & 590] cept the dry ice. When that evaporated in use he retained nothing acquired from the patentee from which to imply a license to renew or repair the purchased "device". It is true that the shipping box may be an enduring part of the patented package; and perhaps this should be considered as though purchased from the patentee, since its use in the combination was authorized although purchased from others. But to refill the shipping case with its vital element, the dry ice, would be not to renew a subordinate part but to reconstruct the patented package. That Mr. Justice Brown's opinion did not sanction such a reconstruction is clearly implied from his citation of Cotton Tie Co. v. Simmons, 106 U. S. 89, and his illustration of refilling the shell of a patented torpedo, to which we have already made reference.

If the patent is valid, as we have held it to be, we find no reason to doubt that the defendant was a contributory infringer. Accordingly the decree is reversed with directions to enter a decree for injunction and accounting in favor of the plaintiffs.

[Endorsed:] United States Circuit Court of Appeals, Second Circuit.

[fol. 591] In United States Circuit Court of Appeals, Second Circuit

American Patents Developement Corporation et al., Plaintiffs-Appellants,

v.

Carbice Corporation of America, Defendant-Appellee

Decree—Filed Feb. 10, 1930

Appeal from the District Court of the United States for the Eastern District of New York

This cause came on to be heard on the transcript of record from the District Court of the United States for the Eastern District of New York and was argued by counsel.

On consideration whereof, it is now hereby ordered, adjudged, and decreed that the decree of said District Court be, and it hereby is, reversed, with costs and with instructions to enter a decree in conformity with the opinion of this court.

It is further ordered that a Mandate issue to the said District Court in accordance with this decree.

Wm. Parkin, Clerk.

[Endorsed:] United States Circuit Court of Appeals, Second Circuit.

[File endorsement omitted.]

[fol. 592] Clerk's certificate to foregoing transcript omitted in printing.

[fol. 593] Supreme Court of the United States

Order Allowing Certiorari—Filed April 21, 1930

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Second Circuit is

granted. And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

Endorsed on cover: File No. 34,826. U. S. Circuit Court of Appeals, Second Circuit. Term No. 54. Carbice Corporation of America, petitioner, vs. American Patents Development Corporation and Dry Ice Corporation of America. Petition for writ of certiorari and exhibit thereto. Filed February 27, 1930. File No. 34,826.